

**A Selected Survey of Silvicultural Systems and
Harvesting Practices on Haida Gwaii / the Queen
Charlotte Islands**

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For

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By

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INTRODUCTION

The purpose of this study is to characterize silviculture systems on Haida Gwaii. Characterizing will involve presenting quantitative data as well as qualitative information. A number of people were interviewed for this paper. Many individuals volunteered their opinions and these are incorporated into the paper. The report is oriented towards pointing out where there are significant issues to be considered regarding silviculture systems on the Queen Charlotte Islands and, where possible, to frame the discussion.

The paper is written in a way that avoids the use of technical terms or acronyms. A few technical terms are used and some acronyms are unavoidable.

In presenting the issues around silviculture systems this paper uses graphs and tables to convey quantitative data. Photographs and written descriptions are used to convey qualitative information. The paper also makes extensive use of maps since maps are a useful tool to communicate how forest resource values are managed by different silviculture systems.

This paper is presented in six parts. To begin with, the paper provides a brief description and definitions of the different silviculture systems used on Haida Gwaii. The report also provides a short summary of several papers that are good introductions to this study.

The main body of the paper involves the review of harvest openings completed in the time period of January 1, 2000 to March 1, 2003. In this time period 287 openings were harvested representing approximately 6,700 hectares. The data available from the Ministry of Forests for all these harvest openings was analysed in Part 3. Thirty harvest areas were randomly selected and field reviewed. These harvest areas represent, on average, how harvesting occurs on Haida Gwaii in 2000-2003. Part 4 is a detailed analysis of these thirty harvest openings. Finally, the forest companies and Small Business Forest Enterprise Program (SBFEP) showed the author a number of harvest areas they consider to be 'Best Management Practices' and these areas were also field reviewed. Conclusions and recommendations are provided in Part 6.

There are four forest companies active as major tenure holders on Haida Gwaii. They are:

- Husby Forest Products Ltd. (Husby): Husby manages a number of Forest Licenses (FL) at the north end of Graham Island at Eden Lake.
- J.S. Jones Ltd. (JS Jones): JS Jones manages on behalf of the licensee TFL Forest Ltd. The tenures include Tree Farm License (TFL) 47 and several Forest and Timber Licenses primarily at the south end of Graham Island and the north end of Moresby Island;
- Western Forest Products Ltd. (Western): Western manages TFL 25 at Sewell Inlet on Moresby Island; and
- Weyerhaeuser Company Ltd. (Weyerhaeuser): Weyerhaeuser manages TFL 39 and several Timber and Forest Licenses on Graham Island, Moresby Island and Louise Islands.

In addition the Small Business Forest Enterprise Program (SBFEP) is a program of the Ministry of Forests. The SBFEP plans harvest areas for the benefit of small scale logging businesses. The licensees are individual small scale loggers who win the rights to harvest individual areas under a competitive bid system. At the time the study cutblocks were harvested the SBFEP is a program of the Ministry of Forests managed by personnel at the Queen Charlotte Forest District. This

paper will loosely include SBFEP as a 'licensee' even though 'manager' is more precise. SBFEP harvest areas occur throughout the working forest of Haida Gwaii including Forest Licenses and the TFLs.

It is important to note that this paper was written with the intention of characterizing silviculture systems in common usage on the Queen Charlotte Islands. The field work was not an audit. The author received excellent cooperation and participation from licensees. During the field work the author emphasized with the licensee personnel and other interviewees that the paper was to present issues to understand today's forestry practices and work towards improving them into the future. We can only understand current forestry practices on Haida Gwaii by understanding how we have evolved from past practices. Throughout the paper the author avoids identifying the licensee. While the harvest area names are identified and readers could use these to discern the identity of the licensee, the author urges the reader to remember that the discussion is based on a random selection of cutblocks intended to say something about silviculture systems and not the performance of individual licensees.

PART 1 – DEFINITIONS

Definitions are taken from Ministry of Forests publications such as regulations and Forest Practices Code guidebooks.

A **silviculture system** is a planned program of silviculture treatments throughout the life of the stand to achieve specific goals and objectives. Silviculture systems include treatments of harvesting, regeneration and stand tending methods which covers the entire length of a rotation or cutting cycle.

In British Columbia forest management is conducted on individual 'cutblocks' as the basic unit. A cutblock is also often called an 'opening' or even 'block'. It is described by an outside boundary defined on a map with a variety of management treatments prescribed for the areas inside the boundaries by a plan or most often by a 'silviculture prescription'. On the coast of British Columbia cutblocks are most often up to 40 or more hectares in size. Forest managers understand the cutblock as the basis of 'stand' level of management. A 'stand' is an area of trees that is distinct in terms of age, species composition, crown closure or other significant factors from surrounding trees. A cutblock may have one or several stands that may be managed differently.

Silviculture systems manage stands as either 'even aged' or 'uneven aged' stands. **Even-aged** stands are those where the trees fall into of one or two age classes. Generally even aged stands are re-established within a short period of time after harvesting. Even aged stands can result in trees of a stand in two or more layers; however, the trees by definition are in a narrow age range (within 20 percent of the length of the rotation). Even aged silviculture systems generally establish a pattern of harvest followed by a long period (the 'rotation') in which the trees grow (often with a variety of treatments) to achieve the desired characteristics.

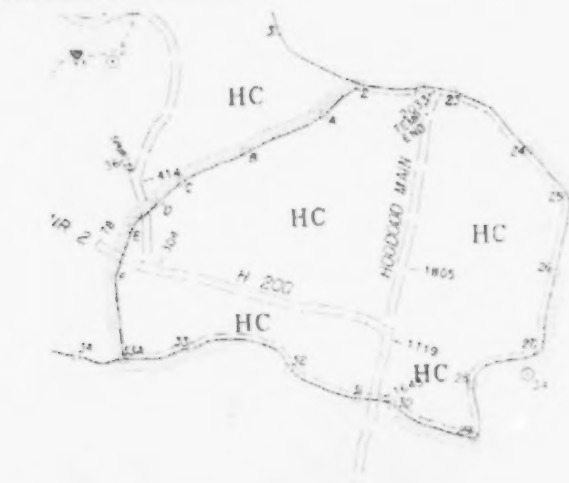
Two silviculture systems dominate forest management on Haida Gwaii. They are 'clearcut with reserves' and 'retention' systems. Both are even aged silviculture systems.

Clearcut means a silvicultural system that:

- (a) Removes the entire stand of trees in a single harvesting operation from an area that is;
 - (i) 1 ha or greater, and
 - (ii) at least 2 tree heights in width, and
- (b) Is designed to manage the area as an even-aged stand.

Figure 1 shows an area managed with a clearcut silviculture system. The white tubes are planted western redcedar protected from deer browse.

Figure 1 Cutblock HD2011 - Clearcut



Stand level reserves are identified single trees or groups of trees, or a mixture of both, that have been designated on a cutblock to be retained to manage for one or more values for a defined period to meet objectives other than regeneration. Reserves are commonly prescribed to protect streams, fisheries, cultural, recreation or many other values. Most commonly reserves are prescribed to provide values important to the retention of biodiversity or the management of wildlife. The use of reserves can be compatible with any silviculture system.

So **clearcut with reserves** is a variant of the clearcut silviculture system in which trees are retained, either uniformly or in small groups, for purposes other than regeneration. Figures 2 and 3 present two cutblocks managed as clearcut with reserve silviculture systems. It should be noted that when viewing the cutblock in Figure 2 the reserve is not evident since it is a continuous forest with the non-harvested portion of the cutblock.

Figure 2 Cutblock TOR 039 – Clearcut With Reserve



Figure 3 Block 94 – Clearcut With Reserve



Figure 2 Cutblock TOR 039 – Clearcut With Reserve

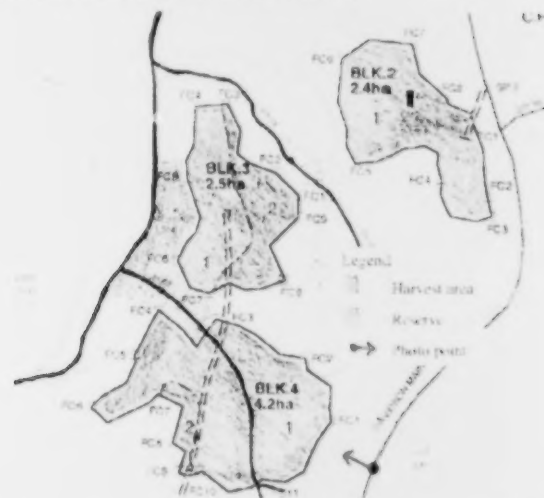


Figure 3 Block 94 – Clearcut With Reserve





It should be noted that the term 'reserve' used in forestry can have different definitions. In this paper the term reserve means that little or no harvesting will occur. Reserves are designed to manage for ecosystem integrity or any number of resources such as culture, recreation, fish, wildlife or other resources. In this paper the reserve is designated on a map but there is no assurance that this designation implies any kind of permanent protected status.

The other silviculture system in common usage on the Queen Charlotte Islands is the 'retention system'. **Retention system** means a silvicultural system that is designed to:

- (a) Retain individual trees or groups of trees to maintain structural diversity over the area of the cutblock for at least one rotation, and
- (b) Leave more than half the total area of the cutblock within one tree height from the base of a tree or group of trees, whether or not the tree or group of trees is inside the cutblock.

Figures 4 and 5 show some retention silviculture system cutblocks. Though it is difficult to capture on a photo when viewing a retention silviculture system cutblock on the ground it is easier to discern that there are retention areas that have not been harvested. It should be noted that retention can be short-term or longer-term and this is usually defined in the plans or prescriptions.

Figure 4 Cutblock SH 50C - Retention

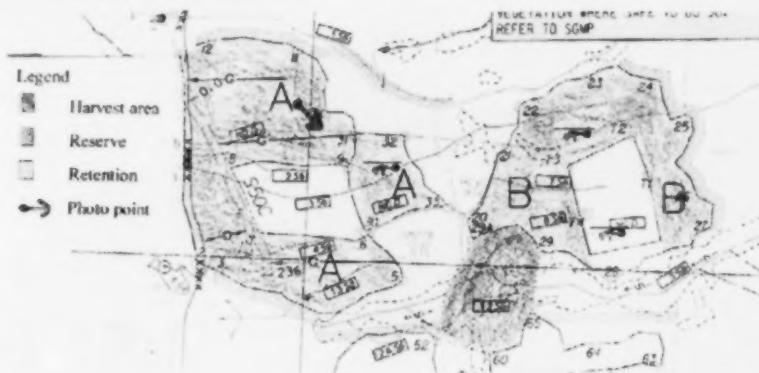




Figure 5 Cutblock AWUN 82 – Retention

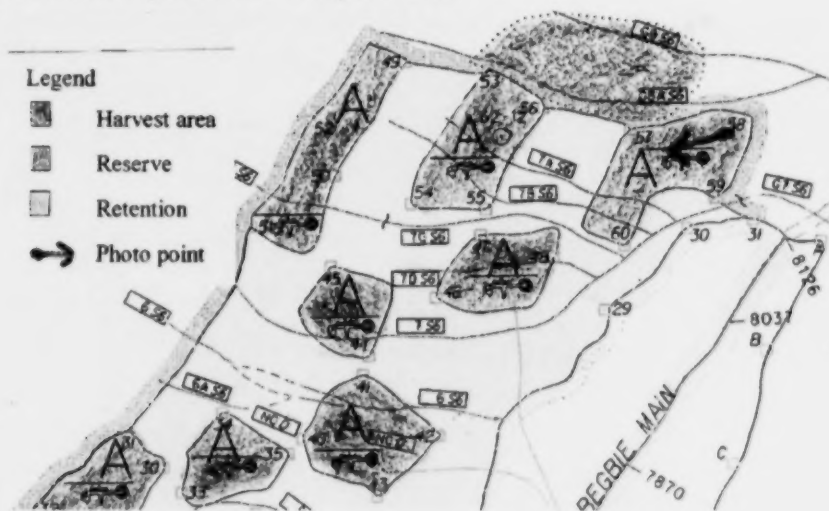




There are several other silviculture systems that have been used on the Queen Charlotte Islands in the past several years. They are the 'group selection' system (uneven aged system) and the 'strip shelterwood' system (even aged system).

Figure 6 shows the map and a photo of a group retention silviculture system. This system is not the same as 'group selection' (see description later in this section); it is a variant of the retention silviculture system. In the example the cutblock also has a reserve. It is readily apparent, when on the ground, that areas have been retained from harvesting.

Figure 6 Cutblock Begbie 300H – Group Retention





The **shelterwood** silviculture system removes mature trees in a series of cuts to achieve a new even-aged stand under the shelter of the remaining trees. On Haida Gwaii, it is the 'strip' shelterwood that has been used, in which trees are harvested in progressive, usually linear cuts in narrow successive strips. In figure 7 the brown coloured strips have been harvested and the yellow strips with dots will be harvested in future passes once the original harvested strips have regenerated. This example of a strip shelterwood also has a reserve. When viewed on the ground it is readily apparent that areas have been retained from harvesting.

Figure 7 Cutblock A58350 – Strip Shelterwood With Reserve





The shelterwood system harvests the stands over up to three cut phases: preparatory cut (improve vigour and windfirmness of remaining trees), regeneration cut (sufficient overstory trees are removed to establish a new stand in the understory) and finally the overstory removal cut (remaining overstory trees are removed or may be retained to satisfy objectives other than regeneration). Shelterwood silviculture systems are commonly used to modify the microclimate of the regenerating trees, provide seed to regenerate the next stand and provide site occupancy and volume during the regeneration phase.

There are a number of other even aged silviculture systems that may be used on Haida Gwaii but have not been featured in this report. They include the 'patch cut' system and the 'seed tree' system.

Uneven aged silviculture systems develop three or more distinct and well represented age classes. The management goal is to create and then maintain the stand and age structure over time. Harvesting occurs over specified repeated intervals ('cutting cycles') which encourages frequent establishment of regeneration in canopy gaps. Harvesting is of single scattered individuals or small groups of individual trees. Silviculture systems that produce uneven aged stands are often referred to as **selection systems**.

Single tree selection systems are uneven-aged in which new age and/or diameter classes are created by the removal of individual trees or small clusters of trees of all size classes, more or less uniformly throughout the stand. The system creates or perpetuates the multi-layered uneven-aged nature of the stand by creating very small canopy gaps. Historically, natural regeneration is the basis for re-establishing new trees for selections systems; however planted regeneration is also a viable option.

Over the long run, cumulative volume removals from a well-stocked uneven-aged stand managed under the single tree selection system should balance the average periodic volume increment for the stand over the same time. In addition to controlling volume removal, the selection cuts must maintain stand structure and characteristics to achieve long-term stand-level management objectives.

Figure 8 Cutblock DIV 107 – Single Tree Selection



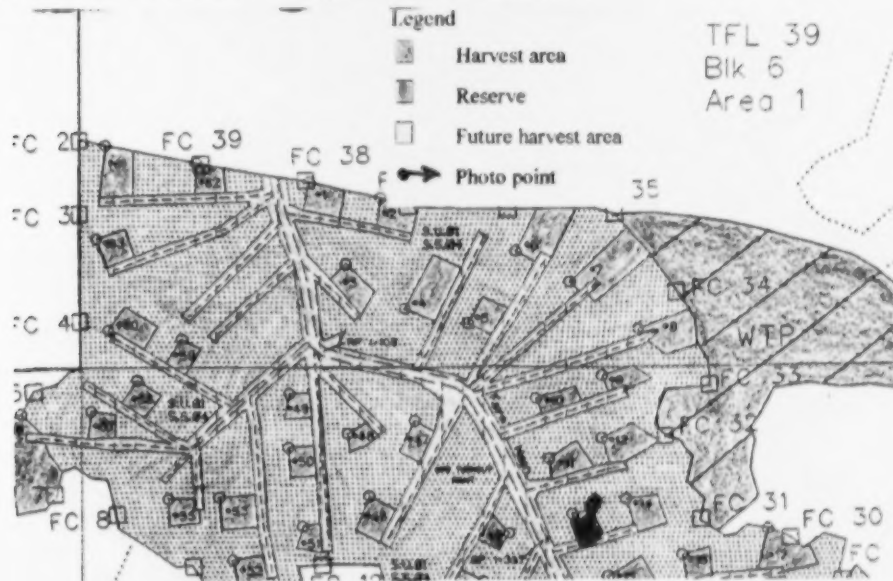
Group selection means a silvicultural system that:

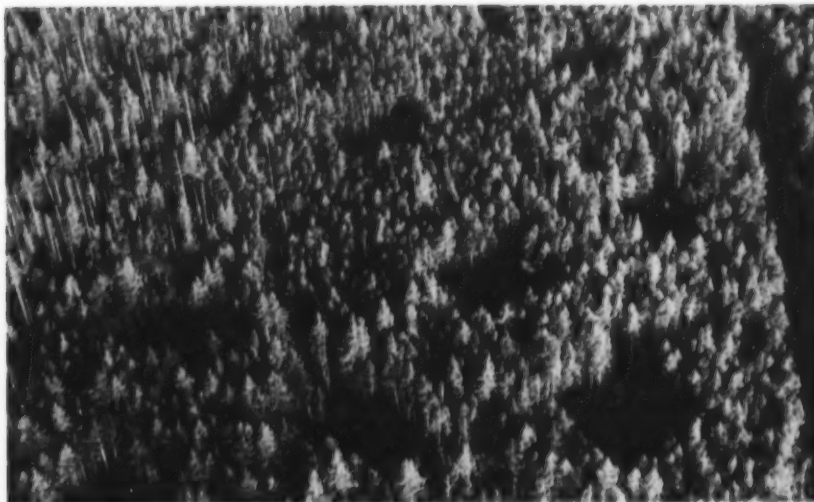
- (a) Removes trees to create openings in a stand less than twice the height of mature trees in the stand, and

(b) Is designed to manage the area as an uneven-aged stand.

Figure 9 shows a group selection silviculture system cutblock that also has a reserve. When viewed on the ground it is easily evident that areas have been reserved from harvesting.

Figure 9 Cutblock A61092 – Group Selection With Reserve





A word of caution is in order. 'Partial cutting' is a term that is used, often as a synonym to 'selection system'. Partial cutting can refer to even aged and uneven aged silviculture systems. The Ministry of Forests defines **partial cutting** as a silvicultural system in which only selected trees are harvested and includes:

- (a) Shelterwood (even aged);
- (b) Single tree selection (uneven aged);
- (c) Group selection (uneven aged);
- (d) Retention system (even aged); and
- (e) Clearcutting with reserves (even aged).

PART 2 – SELECTED COASTAL SILVICULTURE SYSTEM STUDIES

There are many research studies pertaining to silviculture systems in the Pacific Northwest (California to Alaska including British Columbia). This report does not review the literature. However, during discussions with managers and others on the Queen Charlotte Islands, a number of studies frequently came up in conversations. This paper will briefly review the following reports:

- Hangover and Gregory Creek silviculture system study by Brian D'Anjou (2000);
- Clearcutting Canada's Rainforest (Status report 2002) by David Suzuki Foundation; and
- Silviculture Options in the Central Coast (Pojar et al, 1999).

Brian D'Anjou is Research Silviculturist at the Vancouver Forest Region. D'Anjou has been conducting a number of research studies into silviculture systems on the coast. The Hangover and Gregory Creek Study (D'Anjou 2000) was conducted on Haida Gwaii in Rennell Sound. The study sites were located on the steep slopes of Hangover and Gregory Creeks. The silviculture systems tested included single tree selection, group selection and clearcutting.

At Hangover/Gregory Creeks D'Anjou (2000) found that the harvest strategy of hand falling and helicopter yarding proved capable of creating small gaps of less than 0.3 hectares and of removing single trees with little disturbance to the forest floor. Gaps between 0.3 to 0.6 hectares were more efficiently harvested. The single tree selection treatment was to achieve only a 25% basal area removal. However due to operational constraints, primarily safety, fallers could not achieve this objective and more trees were removed. It was easier to achieve the retention objective in the group selection treatments (25% and 50% basal area removal). The single tree selection system had higher residual tree damage than the group selection systems.

At Hangover/Gregory Creeks the natural regeneration species composition within the single tree selection, group selection and clearcuts were similar. Regeneration densities were highest in the group selection systems over the clearcut. Conifer growth rates in the gaps (group and single tree) were lower than the height and diameter growth rates of the clearcut site. D'Anjou (2000) suggests gaps of at least 0.3 hectares for tree growth to begin to match that of the full light condition of clearcuts.

Finally D'Anjou notes that the single tree selection cutting pattern simulates the common stand initiating events of the Queen Charlotte Islands such as disease, insects and windthrow, killing individual trees and creating small gaps. Other common stand initiating events include landslides and larger windthrow events which group selection cutting patterns can simulate.

The David Suzuki Foundation, Forest Watch of British Columbia and the Raincoast Conservation Society conducted a study of clearcut logging and fish streams on the north coast. The study called 'Clearcutting Canada's Rainforest' (2002) has a status report available at www.canadianrainforest.org. The study consisted of a review of 227 logging plans, 90 aerial assessments and 21 ground visits to harvested areas on the central and north coast as well as Haida Gwaii. The Status Report notes the following:

- 80% of the forest within the prescribed area is harvested;
- 85% of small fish streams were logged to the banks with no stream-side buffers;
- Only 4% of plans provide for unlogged buffers on small fish streams flowing through logged sites;
- In 163 of the 227 cutblocks analysed (72%) companies removed 80% of the forest.

Another important and very relevant paper is: "Silviculture Options in the Central Coast" by Pojar et. al. (1999), a report prepared for the Central Coast Land and Coastal Resource Management Plan. The Executive Summary of this paper is provided as an Appendix to this paper. The report by Pojar et al is an important starting point for this Silviculture Systems Survey of Haida Gwaii.

The Hecate Lowlands (outer coast of the mainland) described by Pojar et al. is the same ecological subunit as the west coast of Haida Gwaii ("very wet hypermaritime" – See Green and Klinka (1994) for a more detailed discussion). The Outer Coast Mountains discussed by Pojar et. al. (1999) is the same as the "very wet maritime" (See Green and Klinka (1994) for a detailed discussion) ecological subunit of the Queen Charlotte Islands. These ecological subunits have similar physiographic and economic constraints and challenges to forest management to the Queen Charlotte Islands making Pojar et al's recommendations highly relevant to forest management on Haida Gwaii.

Pojar et al (1999) made the following observations:

- There are no compelling biological or ecological constraints to any silviculture system on an individual stand basis. Landscape consequences depend on the rate and extent of harvest which implies that it does not matter as much **how** but **how much** is logged.
- Virtually all silviculture systems, both traditional and non-traditional, could be implemented in the Central Coast. There are no compelling operational constraints and the most serious silvicultural constraints centre on windthrow, high-grading and forest pests and diseases.
- There is very little partial cutting being implemented in the Central Coast planning area (almost none in old growth timber types).
- The study observed steep-slope cable logging on both steep and moderate slopes, with dispersed retention, patch cuts, and strip cuts; helicopter logging for both dispersed and patch retention, on virtually all terrain and slope types; hoe forwarding on moderate to flat ground, for both patch and low-level dispersed retention as well as in combination with cable harvesting systems.
- Operationally, retention systems are sufficiently flexible to successfully implement in old growth forests. Compared to the classical alternative silviculture systems, retention systems require less planning and layout work, and put more control of tree harvest/retention in the hands of the faller.

Pojar et al (1999) made the following recommendations:

1. Planners should recognize the environmental differences between the ecological subunits and use them in strategic planning;
2. Riparian forests get special treatment and attention;
3. Economic margin should be considered before implementing partial cutting;
4. Partial cutting is not recommended everywhere since this would not make ecological sense and such a strategy could have undesirable silvicultural and economic consequences.
5. Leave more biological legacies to maintain key elements of forest structure.

6. Evaluate the ecological consequences of compressing and truncating natural succession in managed forests at the landscape scale.
7. Implement a variety of silvicultural systems and monitor blowdown and its consequences.
8. At the site level use partial cutting in the following applications:
 - As variable retention systems;
 - To address regeneration delay issues either by retaining advanced regeneration of preferred species in variable retention strategies or by using small patch or strip cuts to protect artificial regeneration.
 - As commercial thinning;
 - To extract some wood from some riparian forests while retaining essential forest structure and ecosystem function.
 - In redcedar/yellow cedar forest types in the Hecate Lowlands several silviculture systems such as group selection, strip, group and irregular shelterwood, variable retention could be implemented most efficiently through hoe forwarding.
9. Establish a process to monitor the effectiveness of different silvicultural systems in meeting social, economic and ecological goals. Consider adaptive management as the model of this process.
10. In groups of individual often parallel small drainages (most apparent in the Outer Coast Mountains) consider compressed harvesting schedules in some drainages and reduced or no activity in neighbouring drainages.
11. Consider trial use of multi-pass silviculture prescriptions to target species and log grades that would allow operations to work within market cycles.
12. Develop ecosystem restoration projects.
13. Continue to allow partial-cut handlogging along parts of the shoreline.

PART 3 – SUMMARY OF ALL HARVEST BLOCKS 2000-2003

The terms of reference for this report called for the preparation of summaries of the following attributes for all the harvest areas on the Queen Charlotte Islands between 2000 and 2003:

- Cutblock name (identifier);
- Licensee;
- Geographic area;
- Licensee compartment or working area;
- Silviculture system;
- Cutblock area;
- Level of retention; and
- Biogeoclimatic subzone.

Queen Charlotte Forest District staff assisted with the project and prepared a list of all openings recorded in ISIS (Ministry of Forest's record keeping system) as having been harvested in the time period from January 1, 2000 to March 1, 2003. The list of openings recorded 302 entries.

- The list of openings was submitted to the five major licensees to identify the licensee's tenures. This list was adjusted to 287 openings as follows:

- Two openings harvested under a Woodlot Licence were removed;
- Thirteen openings were found to have two listings under ISIS where the opening spanned two tenures. These were adjusted into one entry reflecting the correct areas.

The ISIS data has limited value for characterizing the silviculture systems of Haida Gwaii and satisfying the study terms of reference. Unfortunately data was recorded in different ways by different licensees. Wildlife Tree Patches (WTPs), other reserves and retention areas were recorded under different columns in the data base. This lack of consistency meant that it was not possible to analyse the data to determine the level of retention for WTPs, retention areas and other types of reserves.

ISIS was not able to provide the 'net area reforested' (NAR). Only the 'total area under the prescription' (TAUP) was available. TAUP includes all of the area that is managed by one Silviculture Prescription (SP) and includes the land base dedicated to access structures (roads, permanent landings etc.), non-productive area, reserves (including WTPs and other areas reserved from harvest), retention areas (retained for harvesting in the future) and the productive land base. The working land base is the NAR. This is the land base that will grow the next forest. The ideal analysis would present summaries of both TAUP and NAR.

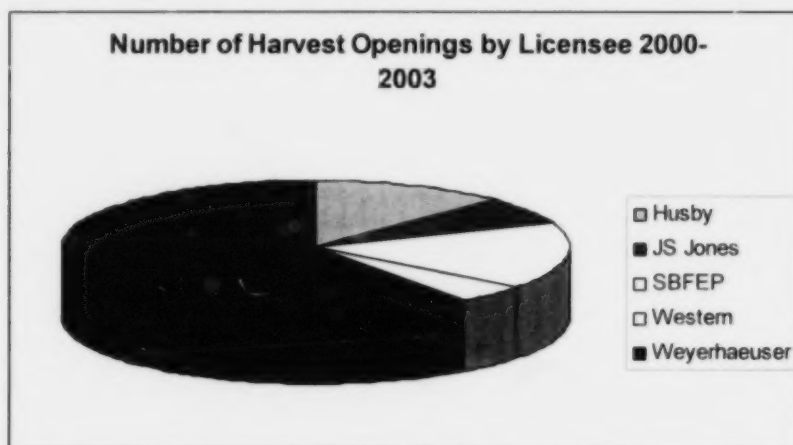
The geographic area and compartment/working area data was not available. As well, ISIS only recorded the silviculture system for the Small Business Forest Enterprise Program.

In order to complete the terms of reference for the analysis of all the harvest openings on the Queen Charlotte Islands between January 1, 2000 and March 31, 2003 all the individual files would have to be reviewed. Though this would undoubtedly yield very useful results, the study was limited by time and resources.

Of the 287 openings harvested in 2000 to 2003 the following were harvested by the different licensees (see figure 10):

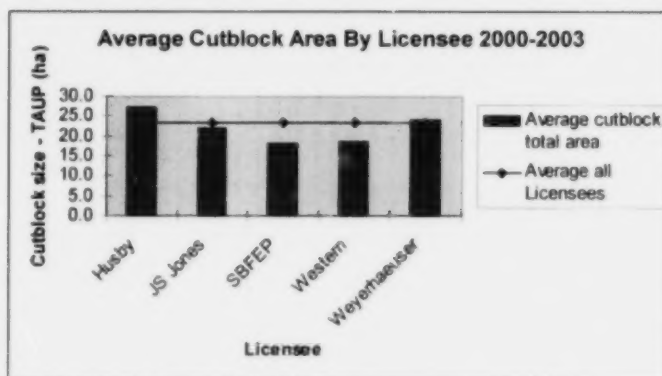
- Husby 36 openings or 12%;
- JS Jones 19 openings or 7%;
- SBFEP 47 openings or 16%;
- Western 13 openings or 5%; and
- Weyerhaeuser 172 openings or 60%.

Figure 10 Number Of Harvest Openings By Licensee 2000-2003



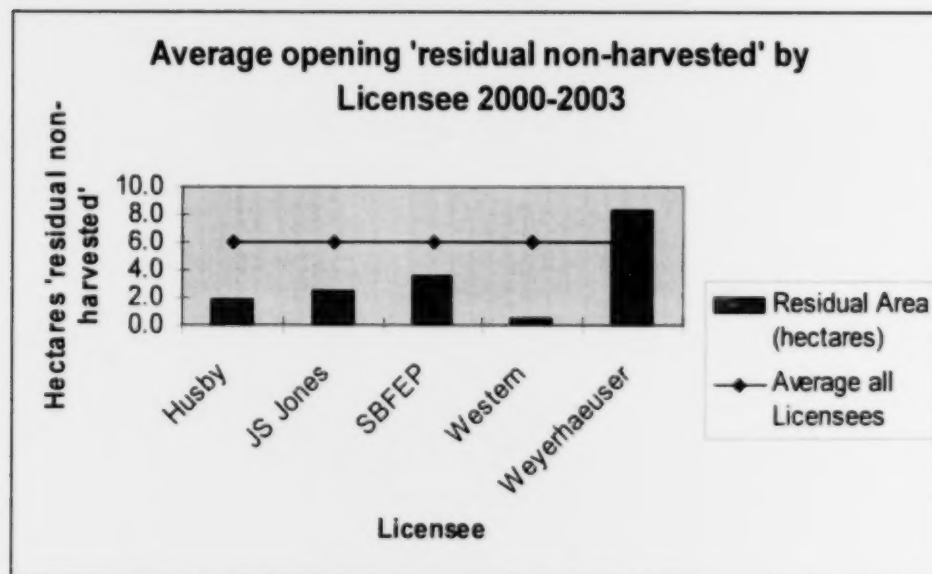
The only data available to analyse opening size is the 'total area under the prescription' (TAUP). This data can be misleading because licensees include area that is not harvested in the TAUP. The average total opening size across all licensees is 23.2 hectares. The average total opening size by licensee fall within a fairly tight range with Western and SBFEP having the smallest average total opening size at 18.3 hectares and Husby with the largest at 27.1 hectares. Figure 11 presents this data. Within the total population of openings the smallest recorded opening was 0.2 hectares and the largest opening was 78.2 hectares TAUP.

Figure 11 Average Cutblock Area By Licensee 2000-2003



An examination of the ISIS data gives an indication of area that has been retained from harvesting in Wildlife Tree Patches (WTPs), other reserves and retention patches. This study calls this area 'residual non-harvested' which has no common meaning or definition by the Ministry of Forests. The residual non-harvested adds together the columns under ISIS where different kinds of non-harvested area within the TAUP could appear. It is important to emphasize that this data is not sufficiently reliable to make any statements about actual average block retention levels. The data is presented in an attempt to characterize the amount of forested area retained on average by licensees. Of note is the high level of 'residual non-harvested' by Weyerhaeuser, presumably due to the inclusion of retention areas that are commonly included under TAUP but not harvested in this rotation. Figure 12 shows this data.

Figure 12 Average Opening 'Residual Non-Harvested' By Licensee 2000-2003

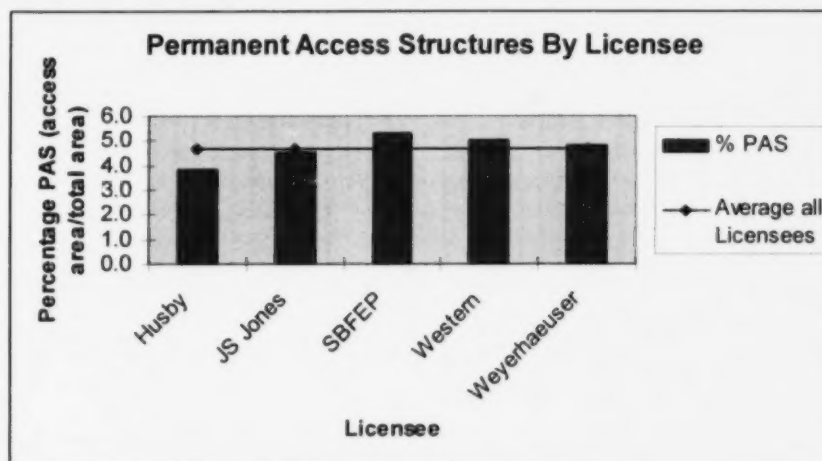


ISIS records the area lost to permanent access structures (PAS) such as roads, permanent landings or trails and gravel pits. PAS is expressed as a percentage of TAUP. The average percentage PAS expressed as an average across five licensees is 4.7% with Husby at a low of 3.8% and SBFEP at a high of 5.3%. Figure 13 presents this data.

Due to limitations with the ISIS data this study cannot make any comments regarding silviculture systems on Haida Gwaii by all licensees. Only data for SBFEP was available. Five different silviculture systems were recorded under ISIS. The total area and number of blocks is (total area also presented in figure 14) harvested between 2000 and 2003:

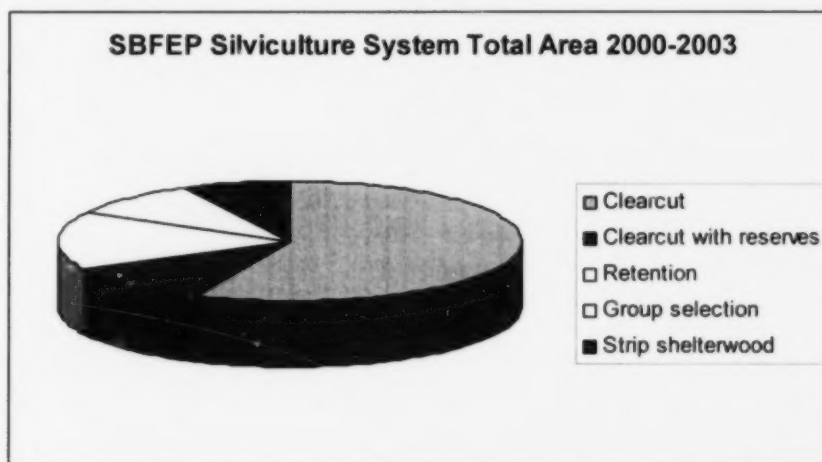
- Clearcut – 32 openings totalling 485.7 hectares;
- Clearcut with reserves – 4 openings totalling 94.2 hectares;
- Retention – 4 openings totalling 132.5 hectares;
- Group selection – 2 openings totalling 82.1 hectares; and
- Strip shelterwood – 5 openings totalling 63.6 hectares.

Figure 13 Average Percentage Permanent Access Structure By Licensee



As will be discussed in Part 4, this data too has limitations. In the detailed examination of 30 randomly selected openings it was apparent that licensees were not consistent in how they identified the silviculture system. Some openings recorded as clearcuts could qualify under the definition of clearcut with reserves if one considered the definition of the silviculture system.

Figure 14 SBFEP Silviculture System Total Area 2000-2003



PART 4 – RANDOM SURVEY OF 30 HARVEST AREAS

A. Introduction

The purpose of analysing 30 randomly selected harvest areas is to characterize the current range of silviculture systems and harvesting practices that are being employed on the Queen Charlotte Islands. The 30 randomly selected harvest areas can be considered to be a snapshot of present practices on Haida Gwaii.

In addition to a site visit to each of the thirty harvest areas, the Silviculture Prescriptions (SP) with the latest amendments was analyzed. Licensee and agency personnel were also interviewed. Other interested individuals were also interviewed.

The project objective was to:

- Collect and summarize information on silviculture systems and management practices applied in forest management on Haida Gwaii implementation in the last 3 years;
- Provide pictorial examples of silviculture systems, through a random sample of cutblocks, and documentation of objectives; and
- Provide documentation of problems and issues with respect to adoption of new silviculture systems, particularly variable retention.

The paper discusses the following problems and issues:

- Silviculture systems;
- Management objectives;
- Cutblock area;
- Windthrow;
- Harvest method;
- Fisheries values;
- Riparian zones;
- Culturally modified trees;
- Terrain stability; and
- Gullies.

In addition to the specific problems and issues the following resource values are discussed:

- Wildlife and biodiversity;
- Recreation;
- Visual resource;
- Culturally modified trees;
- Terrain;
- Watershed and hydrology; and
- Windthrow.

B. Methodology

The project terms of reference specified the sampling intensity by licensee as determined by each licensee's current allowable annual cut. Weyerhaeuser's allowable annual cut has decreased significantly in the past year. The sampling intensity by cut level is detailed in table 1.

Table 1 Project Sampling Intensity

Licensee	AAC	%	Blocks
Weyerhaeuser	600,000*	52	16
Western	115,000	10	3
JS Jones	100,000	9	3
Husby	248,000	21	6
SBFEP	91,000	8	2
Totals		100	30

The harvest areas were chosen using a random number generator from a list of all harvest areas, stratified by licensee from January 1, 2000 to March 1, 2003.

The SP was the basis for determining which features to field review. From two to four hours were spent in the field on each harvest area. Harvest areas were accessed by driving and approximately one-third of cutblocks were visited by helicopter due to road access problems. Field work targeted specific features of special interest at each site. This commonly included windthrow, culturally modified trees (CMTs) and streams.

Digital photos of resource value features were taken at each cutblock. Unfortunately on the day that most of the helicopter access blocks were visited rain prevented good aerial photos from being taken.

A variety of data was taken from the SPs and summarized in spreadsheets. Data collection in the field was limited to taking photos and notes of individual features of interest. The only other field data conducted was to estimate windthrow on each opening.

A qualitative description of windthrow was not sufficient for this study. Field observations consisted of mapping the location of windthrow and estimating intensity or the degree of windthrow. The degree of windthrow is an estimate of the percentage of dominant and codominant trees that have blown over based on an ocular estimate. From the data two numbers were calculated. The area affected by windthrow reflects the estimated area regardless of the level or intensity of the windthrow. By multiplying the level of windthrow by the area affected the relative effect or intensity of windthrow can be determined. It must be emphasized that the data collection for windthrow was rudimentary at best and only serves to characterize the issues.

At one harvest area accessed by helicopter there was no place to land and in the interest of time the survey was restricted to an aerial survey. At another site, again due to a time restriction, only two-thirds of the opening was viewed.

The harvest system analysis was based on map notations, comments from the SP and assumptions made based on topography. The results of this analysis should be considered an estimate.

The stream analysis was based on streams as they appeared on the maps. The basis of the stream analysis was TAUP. Streams were broken into reaches using the following criterion:

- No harvest;
 - WTP;
 - Retention; and
 - Other reserve (CMT etc.).
- Clearcut harvest; and
- Outside TAUP but directly adjacent to cutblock.

Likewise the analysis of gullies, CMTs and other features such as Wildlife Tree Patches (WTPs) was based on map information augmented by field observations.

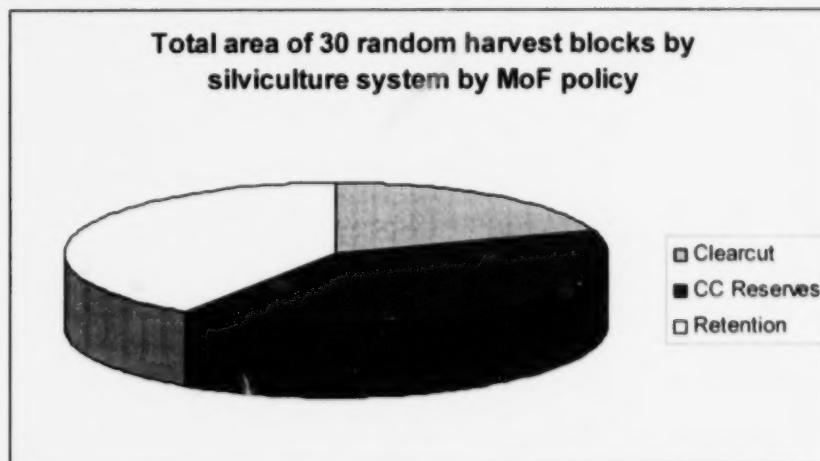
C. Silviculture Systems

Licensees designate the silviculture systems on the SPs and report these to government. The regulations have the definitions of the different silviculture systems and they are described further in guidebooks and various texts and publications.

There is also government policy regarding the designation of silviculture systems. For example where a WTP occurs outside of a cutblock the area of the WTP might be considered outside of TAUP and the cutblock is considered by policy to be a clearcut.

There were three silviculture systems in the thirty randomly selected harvest areas; clearcut, clearcut with reserves and retention. The silviculture systems of the thirty harvest areas as they were reported to the Ministry of Forests are described in figure 15.

Figure 15 Total Area of 30 Random Harvest Blocks By Silviculture System By MoF Policy

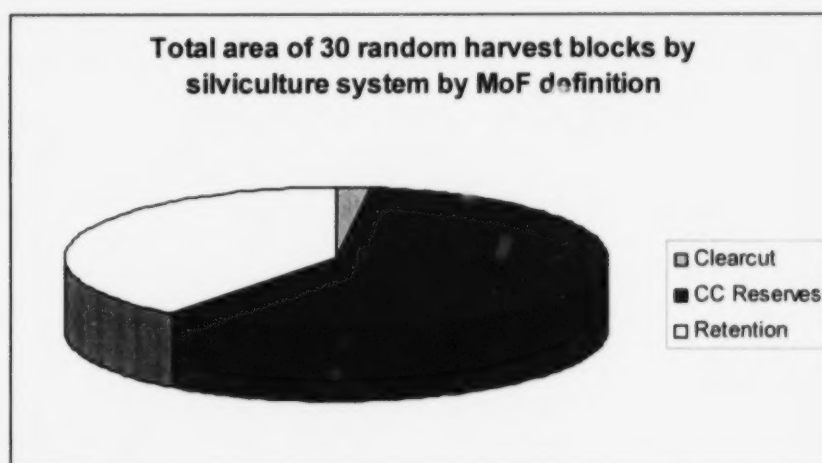


Upon examination of the eight harvest areas designated on the SPs as clearcuts it was apparent that these openings had reserves. Only one cutblock had no reserve prescribed. For seven of the eight cutblocks the SPs had WTPs designated but due to policy or other reason the licensee did not include the WTP in the TAUP and therefore the opening was considered to be a clearcut as opposed to a clearcut with reserve. However, the WTP was designated on the map and the SP referred to the WTP. These seven harvest areas may or may not meet the MoF policy on what is

to be considered clearcut with reserve; however these seven cutblocks are clearcuts with reserves according to the Ministry of Forests definition of silviculture system. Since this study is about silviculture systems and not about government policy the silviculture systems of seven harvest blocks were reclassified for the purposes of this analysis. Where the WTP area was not included in the TAUP the area of TAUP was also adjusted. The analysis in this paper is based on the revised silviculture system designation and revised area calculations.

Of the thirty randomly selected harvest areas one was a clearcut (3%), seventeen were clearcuts with reserves (57%) and twelve were retention (40%) silviculture system. Figure 16 breaks out the total hectares under TAUP for 30 randomly selected cutblocks by silviculture system.

Figure 16 Total Area of 30 Random Harvest Blocks By Silviculture System By MoF Definition



D. Management Objectives

During the time period of this study it is the Silviculture Prescription (SP) that provided 'stand level' management objectives. Higher level (landscape or watershed level) management objectives are provided by higher level plans such as Forest Development Plans. The study reviews the management objectives provided in the SPs of the 30 study cutblocks.

The establishment of management objectives is a critical task in forest resource management. The objectives provide the forest managers with direction for their management. It is usually the landowner who sets the objectives. Since the study pertains to Crown lands it is the public who are the 'owners' (with due deference to the issue of the Haida land claim). It is the public who should be setting the management objectives. In actuality the SP management objectives have been traditionally written by the licensees as the forest managers. The public have had an opportunity to review and comment upon these objectives.

Since the time frames for forest management are so vast it is important to write objectives that provide a target to measure performance against and that are also flexible enough to allow for variations in management approach to respond to operation situations.

The stand level management objectives expressed in SPs tend to be generic to each licensee. Licensees tend to use the same statements for each harvest opening with some variations.

None of the five licensees expressed social or economic objectives in the SPs. This is not surprising since the SP is a stand-level document and setting social or economic objectives is more appropriate to higher level plans. The SPs of one licensee makes specific reference to the management objectives of the Forest Development Plan and the Management and Working Plan as they relate to fish, wildlife biodiversity, recreation visual quality, water quality and cultural/heritage values. Three of the five licensees made specific statements that the management objectives of the SP were consistent with the Forest Development Plan.

The management objectives for all five licensees made reference to the protection of known resource values or site productivity which can be considered as social and long-term economic objectives.

Many SPs offered general management objectives such as:

"To protect known resource values during harvesting operations and duly consider all resource values with the emphasis on habitat when planning silviculture practices over the next rotation."

"To harvest merchantable timber while maintaining soil productivity, water quality, fishery, wildlife, and the integrity of First Nations cultural values. Re-establish a new series of disease-free forest stands with ecologically suitable species and manage these stands under a regime designed to produce a mix of sawlogs and fiber which will maximize volume at both the stand and forest level. Enhance biodiversity where opportunities exist which meet safety and operational feasibility constraints, and operate within existing recreational guidelines and visual quality objectives."

"Regenerate the logged area into crop of commercially and ecologically acceptable tree species suitable for sawlogs and pulp at a rotation of 55 to 80 years, while maintaining adjacent mature forest reserves in amounts consistent with stand and landscape objectives contained in the FDP."

All SPs make some statement about the management objectives of specific resource values. Three licensees formatted the objectives of specific resource values by stating that certain conditions would have to be maintained. The section of the SP dedicated to management objectives then described those conditions. The statements committing the licensee to maintaining certain conditions are:

"Conditions that must exist after harvest or treatment to accommodate known forest resources". "To protect known resource values during harvesting operations and duly consider all resource values with the emphasis on habitat when planning silviculture practices over the next rotation".

"Considerations for specific objectives are given in the associated sections of this prescription"

"Conditions that must exist after harvest or treatment to accommodate known forest resources".

One licensee limited management objectives to those resources that had specific special values in the harvest area. As mentioned three licensees provided statements that the conditions described in the SP would be maintained.

Some samples of specific management objectives are as follows:

Timber: There were few examples of specific objectives related to timber.

"The estimated rotation age for the block is 150 years. Future stand will be healthy, and free of hemlock dwarf mistletoe. Objectives for timber include split between sawlogs and pulp."

"Fully utilize the timber resource and establish a vigorous crop of ecologically acceptable tree species that will provide flexibility for future markets and products while complementing soil conservation, water quality, fish, wildlife, biodiversity, recreation, and landscape values. Currently anticipate 60% sawlog and 40% pulp from future harvests on an anticipated 90 year biological rotation. Special forest products may be salvaged from logging residues."

Fisheries: Most SPs had specific fisheries objectives.

"The objective is to maintain fish habitat in and adjacent to this cutblock."

"To maintain fish habitat located downstream of the opening."

"To protect stream banks, minimize siltation and impact on fish stream habitat."

"Streambanks that require protection such as those adjacent to fish streams and those with sensitive soils, are protected through various protection strategies. These protection strategies vary from riparian management or reserve zones to the maintenance of non-merchantable vegetation and regen for specified distances on either side of the stream. These protection strategies are detailed in the Riparian Management Plan."

"To maintain riparian areas to preserve water quality and stream bank integrity, as per the FPC, to protect fisheries and water values."

"To minimize impacts on water quality and, where applicable, fisheries habitat."

Watershed: Few licensees provided watershed specific management objectives.

"A watershed assessment (CWAP) indicated that any new cutblock is required to have a Low Sediment Delivery Potential. This level of SDP will be achieved by virtue of the small size and low gradient of the streams in the block. Branch 31 crosses five S6 streams having an average channel width of 0.5 m and an average stream gradient of 8%. The stream banks have a dense grassy/sedge ground cover and are very stable. Stream flow is low with many reaches characterized by intermittent disappearance of the stream channel underground, sluggish water movement and an organic substrate."

Wildlife: Few licensees provided wildlife management objectives. Statements relating to WTPs generally were found under Biological Diversity objectives.

"A 6.8 ha wildlife tree patch is located adjacent to the northeast and will maintain mature forest habitat at the level required in the forest development plan."

"To maintain forested land that is representative of the area being harvested with equal or better plant and wildlife features."

Biological Diversity:

"To retain remnants of the harvested stand and to provide for structural diversity at the stand level."

"Wildlife Tree Patch adjacent to riparian area. Pacific crabapple and Western Yew will be considered 'ghost trees' and will enhance biodiversity. Retain on site non-merchantable coarse woody debris in situ."

"To meet the draft biodiversity guideline requirement of 9% for the Ian Landscape Unit."

Recreation: Very few SPs had specific management objectives for recreation.

"Road and cutblock designs will improve access into a previously unroaded area for recreational activities such as hunting, fishing and biking."

"To maintain recreation values and opportunities by adhering to the recreation management class as set by Ministry of Forests."

Visual

"A visual impact assessment indicated that the cutblock is visible from established viewpoints in Naden Harbour. Block design meets district objectives for visual quality."

"To maintain visual quality (VQC's) by integrating visual landscape design principles and procedures in the harvest planning process."

Cultural Heritage: Some SPs had objectives specific to Culturally Modified Trees (CMTs).

"Physical evidence of historic First Nations use will be preserved unless agreed to with the appropriate band council or the archeological branch. Should a (CMT) be discovered within the area to be harvested, work in the immediate vicinity of the CMT will cease and the appropriate Band Council and agencies will be notified."

"To preserve physical evidence of historical Haida use and be consistent with the Haida/Queen Charlotte Island Forest District Operational guidelines, March 1996, for CMT Management and Survey."

"To preserve physical evidence of historic First Nations use unless agreed to with the appropriate band council."

"To identify the existence of archaeological sites that are attributed to aboriginal (Haida Nations) settlement and minimize the impacts of planned activities on these sites."

"The cutblock boundary has been designed to exclude 23 culturally modified trees (CMT) from the harvest area. Each CMT has a no-harvest buffer of at least 30m."

Forest Health

"To maintain forest health and to minimize damage by pests, including disease, insects and deer browse."

"Establish a stand with manageable levels of dwarf mistletoe, resistant to windthrow, and able to withstand short term growth losses associated with deer browsing."

Windthrow

"To prevent and minimize post-harvesting occurrence of blowdown."

Soil Conservation

"Road construction and harvest operations will be designed to maintain the productive capacity on the net area to be reforested."

Because the management objectives tended to be generic this study observed situations where there were specific resource features of an opening that had no related specific management objective. For example on one opening the SP described a requirement to manage for a low risk of sedimentation as prescribed by a Coastal Watershed Assessment Procedure. The SP provided extensive prescriptions for managing sediment delivery risk. However, the SP provided no specific management objectives regarding low sediment delivery.

Another observation is that management objectives were general and not often specific, measurable and achievable.

In conclusion there was good general coverage of management objectives, particularly for the more important values such as fisheries, CMTs and biodiversity. However, management objectives were general and there were many missed opportunities to write management objectives for those values that made one harvest area unique in comparison to others.

E. Cutblock Area

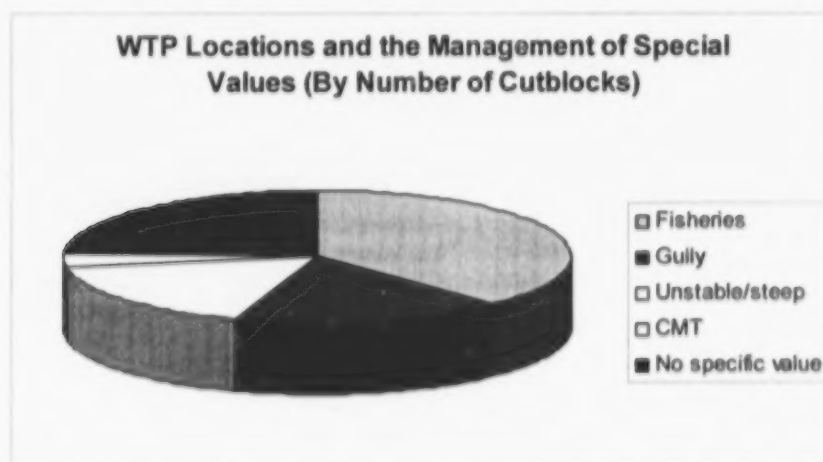
The average Total Area Under Prescription (TAUP) of 30 randomly selected cutblocks is 25.7 hectares. This compares to an average TAUP of 23.2 hectares for the population of 287 openings

harvested in 2000 to 2003 (Part 3). The randomly selected openings ranged in size from the smallest at 4.7 hectares to the largest at 55.4 hectares.

Wildlife Tree Patches (WTPs) are prescribed to manage wildlife values and provide for biodiversity at the stand level. Structures such as large diameter trees, standing (snags) and downed (coarse woody debris) dead trees and other features such as undisturbed understory vegetation are retained in WTPs. The WTP percentage is expressed as the WTP hectares against the TAUP. Individual licensees calculated the WTP percentage in different ways, some using TAUP, some using 'gross' area (TAUP minus permanent access structures) and some using the 'net area reforested' (NAR). Twenty nine of thirty cutblocks had WTPs prescribed. The average WTP size across thirty cutblocks is 9.4% with the largest WTP at 19.5% and the smallest (aside from the clearcut) at 5%. That means that in addition to the NAR, retention and other reserves, there is a WTP equal to 9.4% of the TAUP. While the SPs make no commitment regarding the persistence of the WTPs, this study assumes that once prescribed and mapped by an SP, the WTPs are prescribed for at least one rotation.

WTPs are often placed to manage for other values in addition to wildlife and biodiversity. Figure 16 shows the other values the twenty nine randomly selected openings with WTPs also managed. In many cases WTPs contributed to the management of a number of values, in this analysis the most apparent reason was chosen.

Figure 17 WTP Locations and the Management of Forest Resource Values



When the WTP data for the 17 clearcut with retention cutblocks is separated from the 8 retention cutblocks there is a difference in the size of WTPs as a percentage of TAUP. This data is based on a small sample size so it must be considered an estimate only. Clearcuts with reserves had WTPs of 11.3%, while retention cutblocks had WTPs but only 6.9% of TAUP.

Retention as a percentage is expressed as the hectares of retention against TAUP. Retention areas are prescribed to retain forest structure (such as standing and downed dead trees) on the opening. The SPs make no commitments regarding the persistence of the retention areas. The author contacted the forest managers to determine which of the survey cutblocks with retention prescribed were intended to have the retention areas persist for at least one rotation. One clearcut

with reserve silviculture system cutblock had a 14.5 ha retention area prescribed and the manager indicated that this retention area would be considered for harvest when the adjacent areas had greened up. On an additional four retention silviculture system cutblocks the licensee indicated that there would likely be additional harvesting of retention area and provided an estimate. The total long term retention area was reduced by 23.5 hectares and was not included in the calculations below.

The average retention of thirty randomly selected harvest blocks is 11.2%. Considering only those blocks with retention prescribed for the rotation, the largest retention level is 38% and the smallest is 17%.

Separating out the data for the twelve retention system openings from the rest challenges the data because the sample size becomes small. However, since retention is what differentiates the retention system from clearcutting with reserves, it is worthwhile separating the data for this calculation. The average opening retention over 12 retention silviculture system openings is 26%. This means that in addition to the NAR, WTP and perhaps other reserves, there is retention area equal to 26% of the TAUP.

Twelve of the thirty openings had 'other reserves' prescribed that retained mature timber or other forest structure within the TAUP that was in addition to WTP and retention. These areas are as follows:

- A 'single tree selection' silviculture system stratum of 1.8 ha which is the riparian management zones of class S4 streams inside the cutblock with individual trees removed to manage windthrow (the SP does not prescribe a retention percentage);
- A 0.5 ha stratum has been prescribed to manage CMTs inside the block with only danger (safety) trees removed;
- A class S3 stream has a 'windthrow management area' prescribed within the riparian management zone of 0.2 ha with 70-80% retention prescribed;
- A 1.1 ha class S3 riparian reserve zone has been retained within TAUP;
- A 0.01 ha reserve has been retained as a 'CMT reserve';
- A 0.7 ha 'windthrow management zone' and a 0.1 ha CMT reserve have been prescribed with 85% retention;
- A 1.6 ha CMT reserve has been prescribed inside TAUP;
- A 2.7 ha reserve of non-merchantable timber has been retained inside the block;
- A 4 ha CMT Management area with no harvesting and a 0.5 ha Management zone to a class S2 stream outside the opening has been prescribed to manage windthrow with two trees marked for removal;
- Four riparian management zones to class S3 streams totalling 1.15 ha are have been prescribed to manage windthrow with a total of 33 marked trees removed;
- A 1 ha stratum has been prescribed in an area with streams with gullies with 17 trees harvested to improve windfirmness; and
- Two windthrow management zones have been prescribed totalling 0.4 ha have 3 and 11 trees marked for removal respectively to manage windthrow.

These prescribed areas of mature timber were identified in a variety of ways in the SPs; as management areas, management zones, reserves or even retention areas.

Each of these areas has differing levels of value as mature timber retained to meet wildlife, biodiversity or other values. Some of these areas are more secure than others in terms of their designation and whether or not they will persist even for just one rotation. In any case, since all

have mature timber of some quality to wildlife and biodiversity the contribution of these hectares should be considered if only as temporary reserves. These other reserves average 2% of TAUP. Of the blocks with other reserves the smallest represented 0.1% of TAUP while the most significant example was 21% of TAUP.

Table 2 Total Area of Forest Retained Within TAUP

Type of mature timber retained	Average % mature timber retained (ha retained/TAUP)	Lower range (%)	Upper range (%)
WTP	9.4	5	19.5
Retention	11.2	17	38
Other Reserves	2.0	0.1	21
Total	22.6	6.5	78.5

It is possible to consider the sum of the WTP, retention and 'other reserves' all as contributing forest structure to the harvested openings, though it is prudent to note that not all of these areas would have an equal contribution in terms of quality or functionality. The total of all area retained as forest is approximately 23% as expressed as a percentage of TAUP. Table 2 summarizes this data.

When the data for mature tree retention is considered by silviculture system it appears that clearcuts with reserves have only approximately 14.9% of the total area under the prescription retained as mature timber while retention silviculture system openings have a mature tree retention rate of 33.4%. Since the sample sizes are small this data (summarized in table 3) should be considered an estimate only.

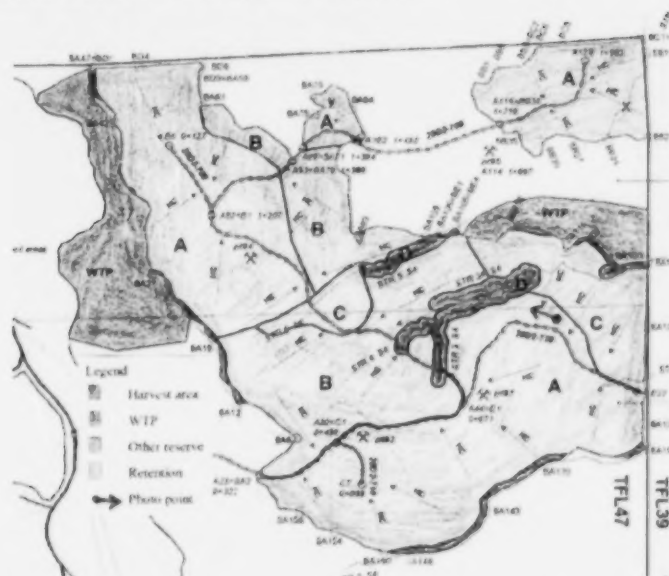
Table 3 Total Area of Forest Retained Within TAUP By Silviculture System

Percentage mature timber retained (against TAUP)	Clearcut with reserve	Retention Silviculture system
WTP %	11.3	6.9
Retention %	1.4	26
Other Reserves %	2.2	0.5
Total %	14.9	33.4

The SPs specify the amount of area lost to timber production in roads, gravel pits etc. These are called 'permanent access structures' (PAS). The PAS is calculated against TAUP. The average PAS across thirty randomly selected blocks is 5.3%. This compares against a PAS level of 4.7% calculated as an average across five licensees for the total population of cutblocks harvested between 2000 and 2003.

Figures 18 to 23 provide examples from the thirty randomly selected cutblocks showing the cutblock maps and photos with descriptions of the cutblock areas.

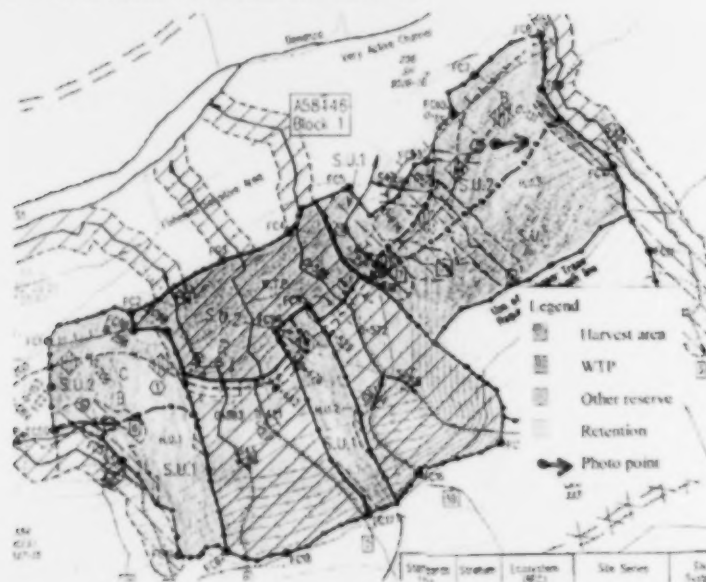
Figure 18 Cutblock GRAY 06 – Clearcut With Reserve



Cutblock GRAY 06 is a clearcut with reserve silviculture system. Class S4 streams are in the WTP, in stratum C and in the cutblock. A CMT is found in the eastern WTP which also protects a class S4 stream. The block has the following characteristics:

- TAUP = 43.1 ha;
- WTP % = 13.5%;
- Stratum C is part of the riparian management area with windthrow-prone trees harvested = 4.2%; and
- Total area of mature tree retention = 17.6%.

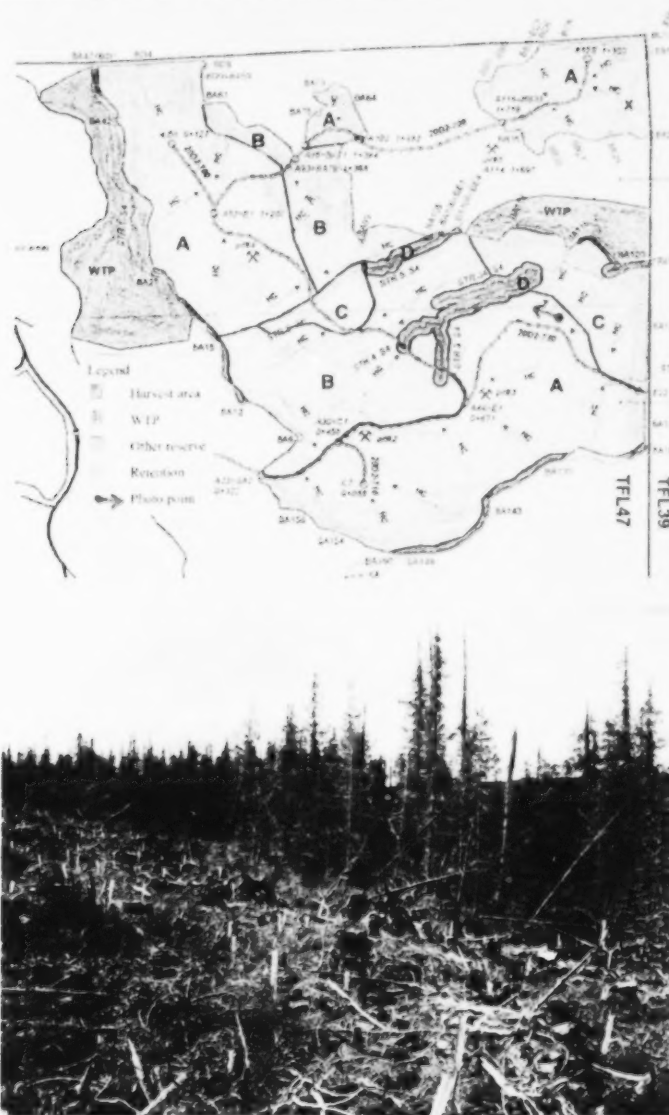
Figure 19 Cutblock A58446 - Clearcut With Reserve



Cutblock A58446 is a clearcut with reserve cutblock. Interestingly although the block is classified as a clearcut with reserve it also has retention prescribed, primarily to manage gullies and class S3 and S4 streams. The WTP also manages fisheries streams and gullies. A windthrow management zone was prescribed along the eastern boundary adjacent to a class S3 stream. The photo shows windthrow along this boundary. The block has the following characteristics:

- TAUP = 21.5 ha;
- WTP = 14%;

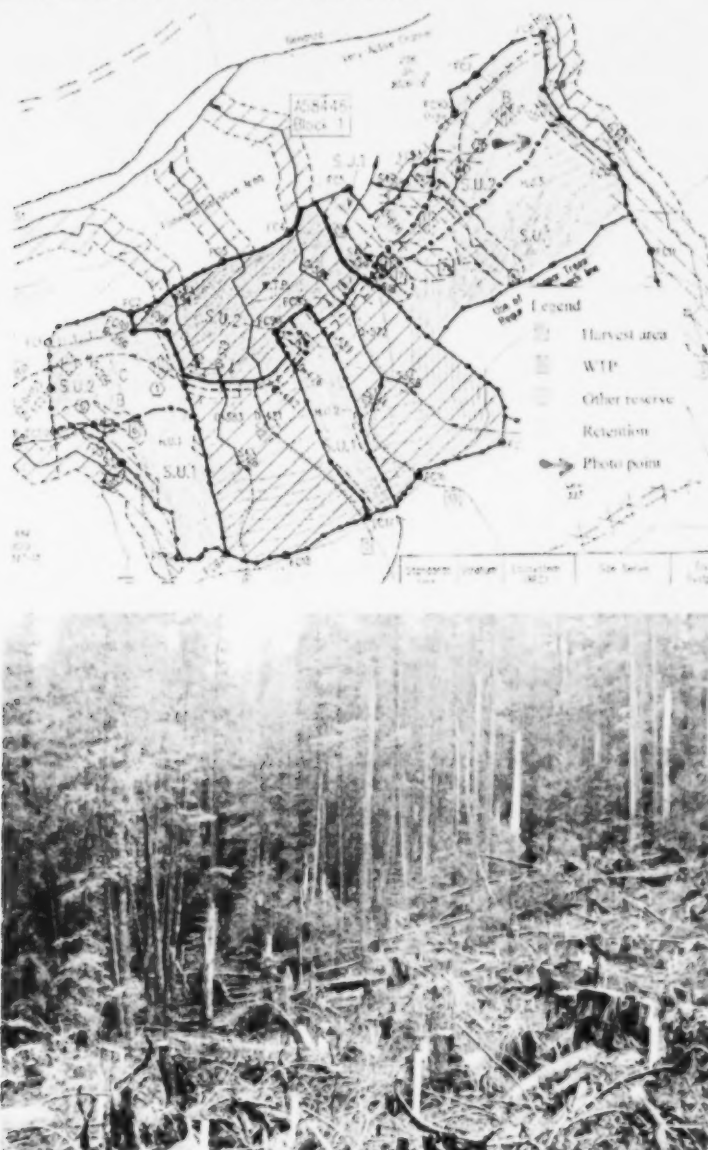
Figure 18 Cutblock GRAY 06 – Clearcut With Reserve



Cutblock GRAY 06 is a clearcut with reserve silviculture system. Class S4 streams are in the WTP, in stratum C and in the cutblock. A CMT is found in the eastern WTP which also protects a class S4 stream. The block has the following characteristics:

- TAUP = 43.1 ha;
- WTP % = 13.5%;
- Stratum C is part of the riparian management area with windthrow-prone trees harvested = 4.2%; and
- Total area of mature tree retention = 17.6%.

Figure 19 Cutblock A58446 - Clearcut With Reserve

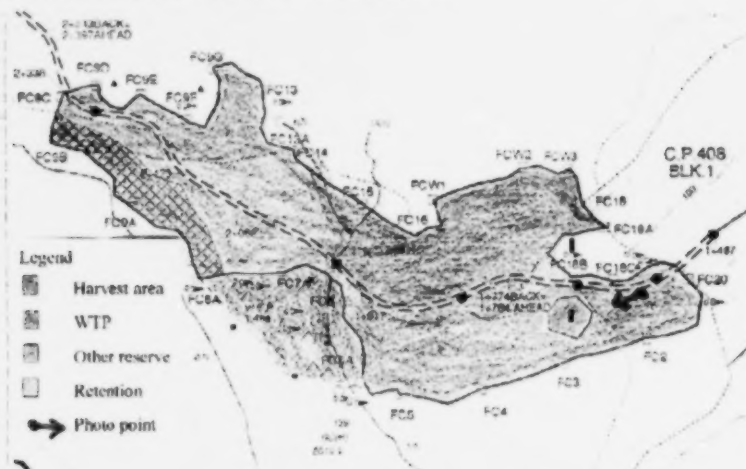


Cutblock A58446 is a clearcut with reserve cutblock. Interestingly although the block is classified as a clearcut with reserve it also has retention prescribed, primarily to manage gullies and class S3 and S4 streams. The WTP also manages fisheries streams and gullies. A windthrow management zone was prescribed along the eastern boundary adjacent to a class S3 stream. The photo shows windthrow along this boundary. The block has the following characteristics:

- TAUP = 21.5 ha;
- WTP = 14%;

- Windthrow management zone = 0.9 %;
- Retention = 30.2%; and
- Total area of mature tree retention = 45.1%.

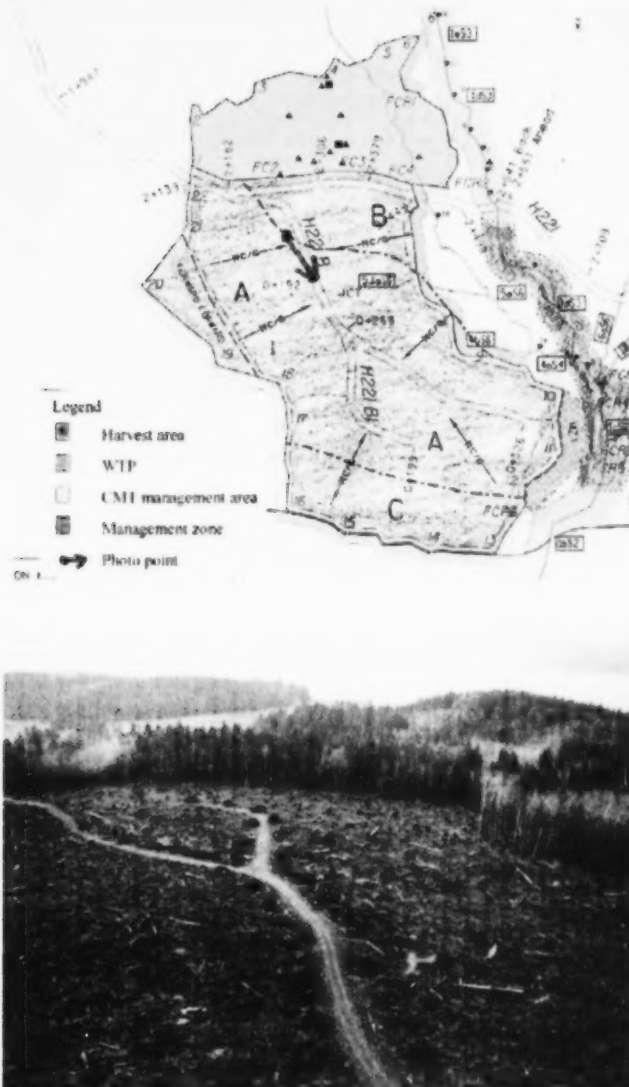
Figure 20 Cutblock STA 015 - Clearcut With Reserve



Cutblock STA 015 is a clearcut with reserve silviculture system. CMTs have been excluded from the opening as well as managing a CMT inside the opening as a CMT reserve (see photo). A windthrow management zone along the south-western boundary was prescribed to protect a class S6 stream. The block has the following characteristics:

- TAUP = 13.3 ha;
- WTP = 10.5%;
- Windthrow management zone + CMT reserve = 6%; and
- Total area of mature tree retention = 16.5%.

Figure 21 Cutblock H216A – Clearcut With Reserve

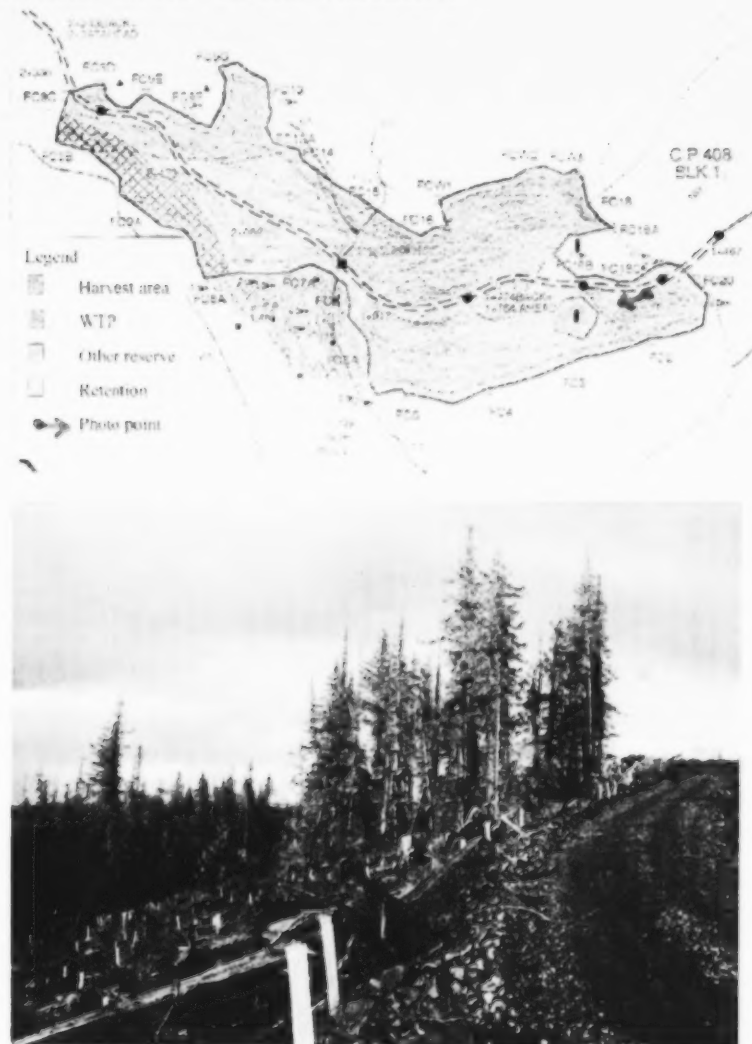


Cutblock H216A is a clearcut with reserve silviculture system. A class S2, S3, S4, S6 stream system has been excluded from the harvested portion of the block along the eastern boundary. The WTP has been placed along this system. A management zone with two trees harvested has been prescribed at the south-eastern end of the block to manage windthrow adjacent to a class S2 stream reach. A CMT management area has been prescribed at the north end of the opening. The block has the following characteristics:

- TAUP = 21.4 ha;
- WTP = 9.8%;
- CMT management area + windthrow management zone = 21%; and

- Windthrow management zone = 0.9 %;
- Retention = 30.2%; and
- Total area of mature tree retention = 45.1%.

Figure 20 Cutblock STA 015 - Clearcut With Reserve



Cutblock STA 015 is a clearcut with reserve silviculture system. CMTs have been excluded from the opening as well as managing a CMT inside the opening as a CMT reserve (see photo). A windthrow management zone along the south-western boundary was prescribed to protect a class S6 stream. The block has the following characteristics:

- TAUP = 13.3 ha;
- WTP = 10.5%;
- Windthrow management zone + CMT reserve = 6%; and
- Total area of mature tree retention = 16.5%.

Figure 21 Cutblock H216A – Clearcut With Reserve

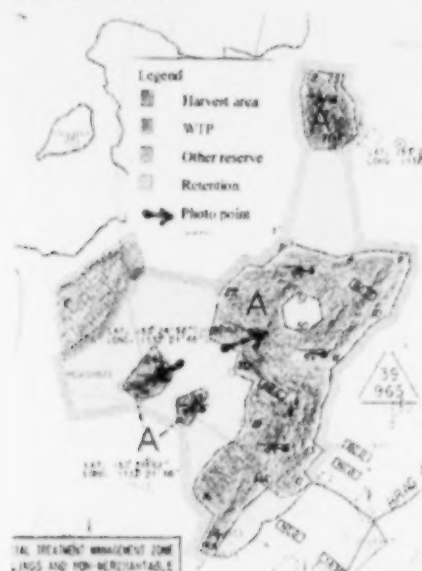


Cutblock H216A is a clearcut with reserve silviculture system. A class S2, S3, S4, S6 stream system has been excluded from the harvested portion of the block along the eastern boundary. The WTP has been placed along this system. A management zone with two trees harvested has been prescribed at the south-eastern end of the block to manage windthrow adjacent to a class S2 stream reach. A CMT management area has been prescribed at the north end of the opening. The block has the following characteristics:

- TAUP = 21.4 ha;
- WTP = 9.8%;
- CMT management area + windthrow management zone = 21%; and

- Total area of mature tree retention = 30.8%.

Figure 22 Cutblock Shiela 216 - Retention





Cutblock Shiela 216 is a retention silviculture system. The block has the following characteristics:

- TAUP = 13.7;
- WTP = 9.5%;
- Retention = 37.2%; and
- Total area of mature tree retention = 46.7%.

Figure 23 Cutblock FLO 1002 - Retention





F. Cutblock Area and Windthrow

Windthrow was a significant concern across the thirty randomly selected cutblocks. In particular the windthrow of WTPs, CMT and other reserves and retention areas is a significant issue. Some foresters interviewed raised the issue of boundaries that were located to follow 'policy', definitions or other imposed 'rules'. They stated that many boundaries cannot be placed at windfirm locations and the resultant windthrow is one of the most significant problems facing forest management on Haida Gwaii. More windfirm locations are those at topographic breaks, at timber type changes or other natural landscape features. One logging contractor and several professional foresters interviewed indicated that windthrow was a very significant issue for the retention silviculture system. The retention silviculture system is differentiated from other silviculture systems by the regular retention of stands or individual trees across the harvest area. By definition many retention boundaries cannot be chosen at windfirm locations since the location of retained trees is dictated by the 'rules' or definition of the silviculture system. Likewise, CMT reserves and riparian reserve boundaries often do not have obvious windfirm boundaries.

The data collected regarding windthrow incidence should be considered an estimate only. Two pieces of data were calculated. The area affected by windthrow reflects the area estimated with windthrow regardless of the level or degree of windthrow. By multiplying the level of windthrow by the area affected one can derive a relative impact indicator for windthrow.

The analysis of windthrow effects on the retention areas considers all prescribed retention areas regardless of whether or not they have been prescribed to be maintained for one rotation.

Eight of the twelve retention silviculture system openings had some level of windthrow. The total area affected by windthrow regardless of intensity was approximately 15.6 hectares or 15% of the area in retention across only twelve retention silviculture system openings. When the

intensity of the windthrow is considered the relative impact is approximately 7.7 hectares or 7.4% of the total retention area.

Several individuals interviewed noted that it is the isolated retention patches that seem to have a much higher incidence of windthrow. Retention as 'peninsulas' (connected to the boundary, WTP, retention or other retained mature timber but creating a boundary that juts out into the harvest area) or 'islands' (small areas of retained mature trees fully isolated within the harvest area) are more exposed to windthrow. The author attempted to break out the peninsulas and islands from the rest of the retention area data. This was somewhat arbitrary without specific criterion agreed upon by a wider community of foresters. The author estimated that approximately 23% of the prescribed retention of the twelve retention silviculture system cutblocks occur as peninsulas and islands. The total area of the peninsula and island retention affected by windthrow is approximately 51%. When the intensity of the windthrow is considered the relative impact is approximately 25% of the total retention area. While this data is not sufficiently rigorous to make definitive conclusions, there is a strong suggestion that isolated retention patches sustain much higher levels of windthrow than retention that is contiguous with other timber boundaries. Figures 24 and 25 show examples of windthrow for the retention silviculture system.

Most of the retention system SPs have provisions for salvage harvesting, if salvage will not jeopardize the retention prescription. One of the cutblocks in the survey had sustained retention area windthrow and the SP had been amended to allow for salvage harvesting that had not yet occurred. A typical example of the wording in SPs that allow for salvage harvesting is as follows: "Windthrow may be recovered if it is economic and safe to do so, provided the requirements of the retention silviculture system are maintained."

The implications of the windthrow on other values such as fisheries are considered later in this paper. The implications of the windthrow of retention patches of the retention silviculture system were expressed by individuals interviewed in this survey and are as follows:

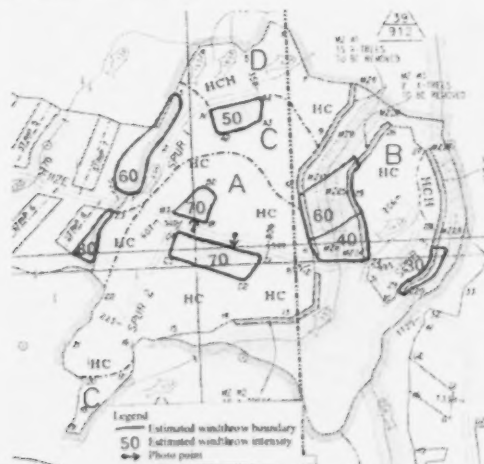
- The retention silviculture system is prescribed to retain mature forest influence over the entire harvest area. The windthrow of retention areas removes this influence.
- While some argue that even windthrown trees have an ecological influence as coarse woody debris others pointed out that windthrown retention trees have a narrower range of ecological value as just one type of mature forest structure not as a wide range of structures.
- Future harvest opportunities of the retention areas may be impacted. If the prescription includes a second pass then the loss of mature timber is an issue but also there may be an additional effect of making the remaining timber uneconomic to harvest. Even if there is no second pass planned, the loss of a significant amount of mature timber across the landscape may have implications to sustainable harvest levels.
- The impact on aesthetics is significant, particularly if the peninsulas and islands sustain higher windthrow rates, and it is these features that the public associate with the retention silviculture system.

Forest managers interviewed indicated that the design of the retention areas has changed significantly over the past several years as managers gain more experience with the silviculture system. Managers now avoid square corners and are taking more care to orient the patches according to the prevailing storm wind direction.

There is no policy written or guidelines available for managers to understand the impact of retention patches that have blown over. If a retention patch is 100% blown down, is it still a retention patch? At what level of windthrow is the patch no longer achieving its objectives to provide mature forest structures?

It is also not clear what the policy is regarding windthrow salvage of retention areas. The windthrown trees have economic value and they also have ecological value as coarse woody debris. How much salvage should be encouraged? What are the criteria under which windthrow salvage is encouraged or discouraged?

Figure 24 Cutblock FLO 1002 Windthrow





The map of retention cutblock FLO 1002 (figure 24) shows the isolated retention patches in the west of the opening (islands) hit hard by windthrow primarily from storm south-west winds. A windthrow report for the opening predicted storm south-east winds. The SP windthrow report predicted a low hazard to windthrow citing the orientation of the boundary parallel to the predicted storm winds and deep well-drained soils. A 10 metre management zone was prescribed to manage windthrow along some of the boundaries. The SP indicates that windthrow salvage is possible as long as the retention rules are maintained. Of particular note is the windthrow across class S3 stream 3 penetrating right through the riparian management and reserve zones. The stream 3 reserve zone is also part of the WTP and retention area is also affected.

Cutblock FLO 1002 has a retention level of 23%. Of the total retention area prescribed 45% is affected by windthrow. Considering the intensity of the windthrow the effective impact of the windthrow is 25%. Of the total retention the author estimated that 21% of the retention was in peninsulas and islands. All of the retention in peninsulas and islands was affected by windthrow and when the intensity of the windthrow is considered the effective impact of the windthrow is 63%. FLO 1002 also has boundary windthrow. A total of 1 hectare of forest along the boundary was affected by windthrow.

Figure 25 Cutblock IAN 708 Windthrow

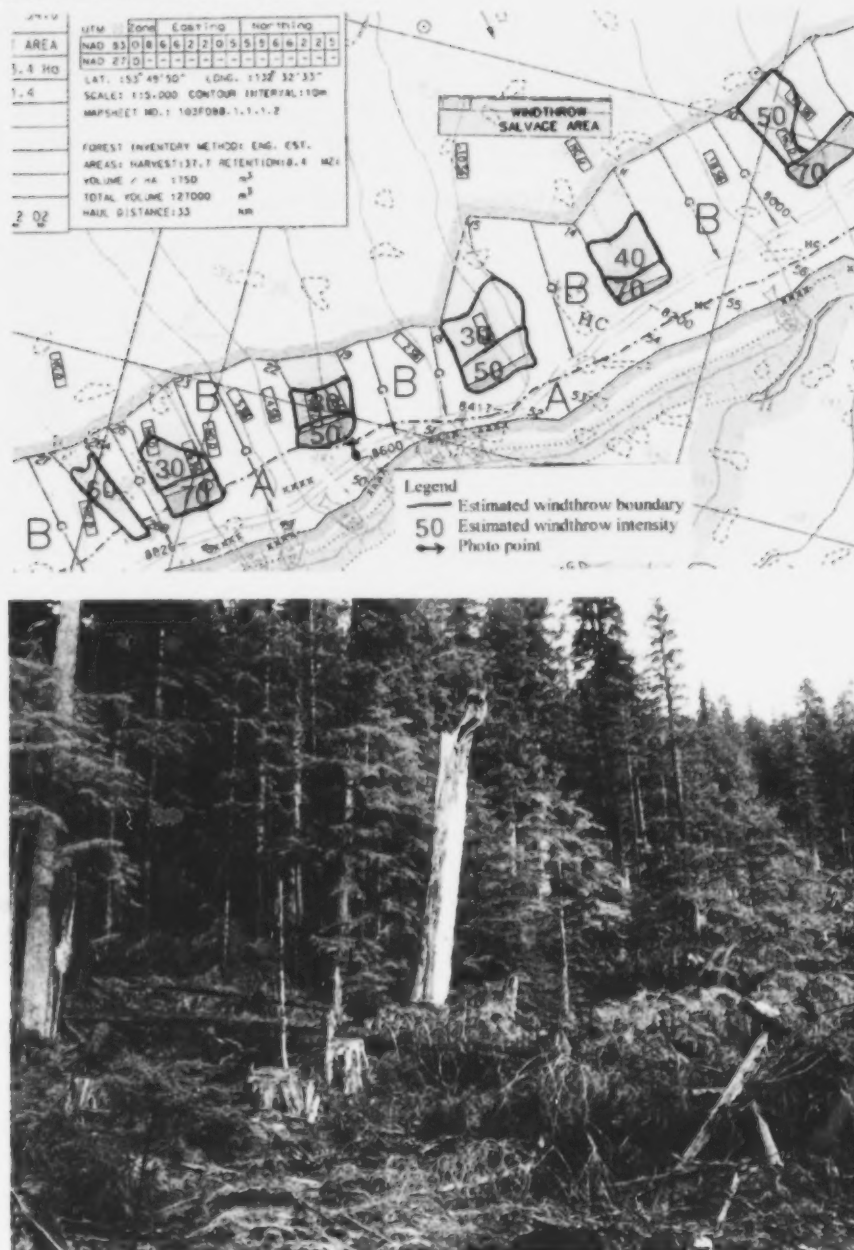


Figure 25 shows retention cutblock IAN 708 on steeper terrain with a retention level of 24%. The opening was cable yarded. The retention patches were affected by windthrow in 2001. The company applied for an SP amendment to salvage harvest windthrow. Subsequent to this application there was additional significant windthrow. The SP predicted storm winds from the

south west which indeed caused the extensive windthrow of the retention patches. The SP stated that the post-harvest windthrow was predicted to be 'not significant'.

Cutblock IAN 708 has a retention level of 17%. All of this retention was considered by the author as peninsulas. Of the total retention area approximately 65% is affected by windthrow. Considering the intensity of the windthrow the effective impact of the windthrow is approximately 31%. There was no significant boundary windthrow, nor did windthrow affect the WTP.

WTPs were also affected by windthrow. Five of the thirty cutblocks had windthrow in the WTP, mostly in very small patches. Expressed as a percentage of the total WTP area of thirty cutblocks this represents approximately 3%. By factoring in the intensity of the windthrow an effective windthrow level for WTPs across thirty cutblocks is estimated at 1.5%. Figures 26 and 27 show WTPs affected by windthrow.

Figure 26 Cutblock GH0 450 WTP Windthrow



Figure 27 Cutblock EAST 03 WTP Windthrow



The survey found that 'other reserves' also had windthrow though the intensity was lower. The other reserve areas had an area affected, expressed against total area of approximately 11%. Expressed in terms of effective windthrow, considering windthrow intensity, windthrow was approximately 2.7%.

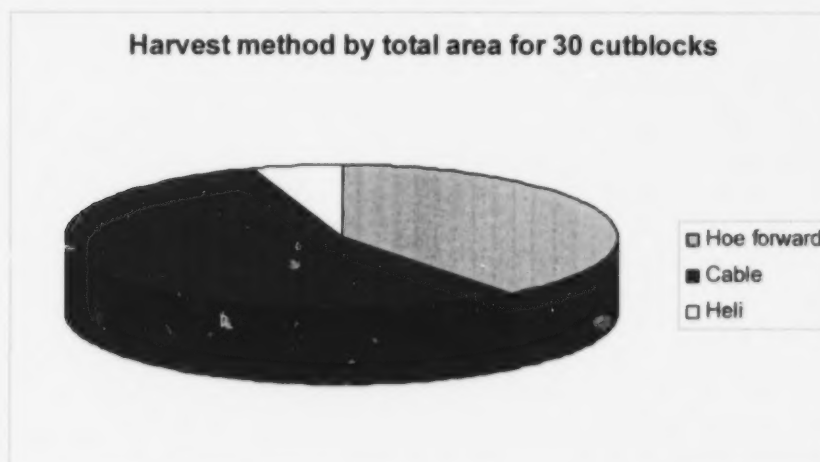
Cutblock boundaries and adjacent unlogged areas were also affected by windthrow. This analysis excluded minor scattered windthrow and only counted windthrow patches 0.1 hectares or larger. The total area affected by windthrow was approximately 9.3 hectares. Expressed as a percentage of NAR (as per the WTP and retention percentage calculations) across thirty cutblocks the area of adjacent timber affected by boundary windthrow is 1.7%. Considering the intensity of windthrow the effective windthrow level is 0.9%. These figures match very well against estimates of boundary windthrow provided by several foresters. This level of boundary windthrow can be expected on retention blocks as well as on clearcut with reserve silviculture system openings. The difference is that the clearcut with reserves do not have the windthrow issues of the retention silviculture system.

The only way to develop an informed position regarding windthrow is to adopt a rigorous monitoring procedure. If all licensees monitored windthrow using the same protocols, within a few years there would be sufficient data available to resolve some of the issues around the effects of windthrow on timber supply and the retention silviculture system.

G. Harvest method

On the thirty harvest openings, harvesting by cable and by hoe forwarding dominate (figure 28). Heli harvesting occurred on approximately 16% of openings as part of the harvest strategy but made up only 5% of the area harvested.

Figure 28 Harvest Method By Total Area For 30 Cutblocks



H. Fisheries values

The Forest Practices Code legislation specifies the retention of forests adjacent to water bodies. Streams are classified into six categories by stream width. Classes S1 to S4 have fisheries values and S5 and S6 do not. The Code specifies a 'riparian reserve zone' where essentially no harvesting is allowed. The 'riparian management zone' is to be managed to maintain the integrity of the riparian reserve zone. The reserve and management zones widths are prescribed for each side of a stream and are summarized in table 4.

Table 4 Forest Practices Code Riparian Zone Widths

Stream Class	Riparian Reserve Zone Width (m)	Riparian Management Zone Width (m)
S1 (fish)	50	20
S2 (fish)	30	20
S3 (fish)	20	20
S4 (fish)	0	30
S5	0	30
S6	0	20

The regulations state that a fisheries assessment is required on every harvested opening. On four of the thirty harvest areas the licensees engaged fisheries specialists in assessments.

Fish streams (class S1 to S4) occurred in or directly adjacent to 50% of the thirty randomly selected cutblocks. Only four of the thirty cutblocks had no streams at all inside TAUP. Of these four cutblocks two had no streams either in or directly adjacent to the cutblock.

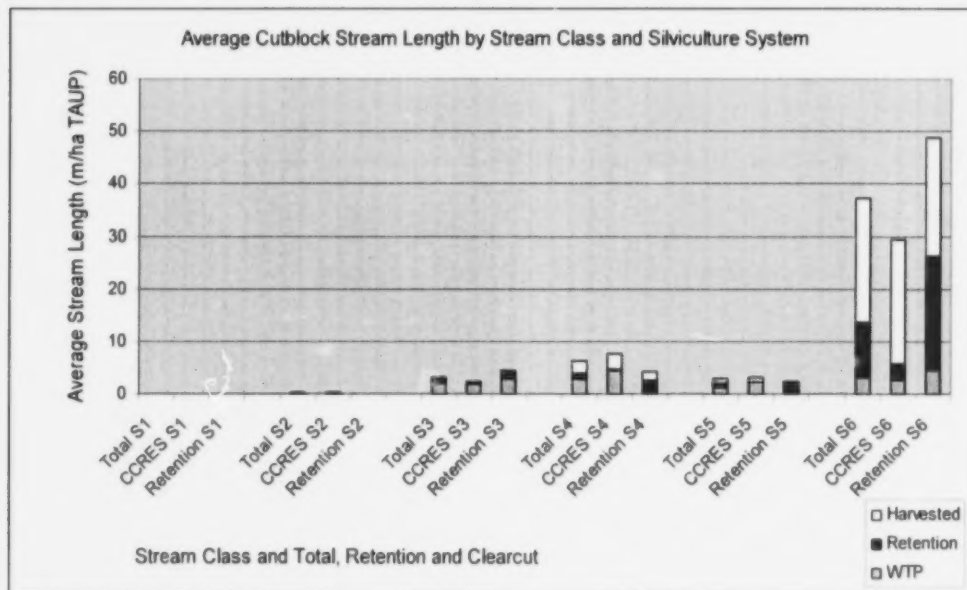
The measure used to express the amount of stream associated with each cutblock is expressed in the length of stream in metres per hectare of cutblock using TAUP as the measure.

A common strategy for laying out harvest areas on the British Columbia coast is to set cutblock boundaries adjacent to streams. In particular class S1, S2 and S3 streams are excluded from the openings with streams approximately parallel to the opening boundaries. Table 4 provides a measure of the quantity of stream reaches with fisheries values occur outside and adjacent to opening boundaries. This data is also presented in figure 29.

Table 5 Average Block Stream Length Inside TAUP By Stream Class

Stream Class	Average Block Stream Length Inside TAUP (m/ha TAUP)			Average Block Stream Length Outside Block (m/ha TAUP)
	WTP	Retention	Harvested	
S1	0	0	0	1.1
S2	0.2	0.0	0.0	4.7
S3	2.2	1.0	0.0	3.2
S4	2.9	1.0	2.3	6.4
S5	1.3	1.0	0.6	1.4
S6	3.3	10.5	23.6	13.6

Figure 29 Average Cutblock Stream Length By Stream Class and Silviculture System



No class S1 or S2 streams occurred inside the TAUP of the thirty randomly selected cutblocks. Class S3 streams were included in TAUP at a rate of 2.8 m/ha TAUP while 3.2 m streams/ha TAUP was found outside and adjacent to the randomly selected cutblocks. However, almost all (except where the class S3 streams crossed roads) of the class S3 stream length occurring inside TAUP was found in WTPs or in retention patches.

Class S4 streams were included inside openings at a rate of 6.2 m/ha TAUP while class S4s were excluded from openings at a rate of 6.4 m/ha TAUP. For the stream length of class S4 streams inside the cutblocks 3.9 m/ha TAUP was retained in WTPs and retention areas while 2.3 m/ha was clearcut. In conclusion when only the area inside of the total area of the cutblock is considered 37% of class S4 stream length is clearcut and 63% protected in reserves or WTPs. This is a very significant finding since the treatment of small fisheries streams with no riparian reserve zones of particular concern in British Columbia.

This study was able to conclude that approximately half of the class S3 and class S4 streams were managed by excluding them from the openings so that they were directly adjacent to the opening. Presumably future adjacent harvesting would also exclude these class S3 and class S4 streams. Forest managers on the Queen Charlotte Islands are managing half of the class S3 and class S4 streams occurring in or directly adjacent to cutblocks by excluding them from openings.

Since the exclusion of class S4 streams is such an effective strategy for managing fisheries values the author considers it to be worthwhile including the length of stream outside but directly adjacent to class S4 streams when considering the rate at which class S4 streams are clearcut. According to the sample of 30 randomly selected openings, approximately 18% of class S4 streams in and directly adjacent to cutblocks are being clearcut harvested on Haida Gwaii

Class S5 streams are non-fish bearing streams and these occurred at a lower rate in the random sample of 30 cutblocks. A total of 2.9 m/ha TAUP of class S5 occurred inside the total area of cutblocks while 1.4 m/ha TAUP of class S5 occurred directly adjacent to the cutblocks. In conclusion when only the area inside of the total area of the cutblock is considered 21% of class S4 stream length is clearcut and 79% protected in reserves or WTPs.

Class S6 streams are small non-fish bearing streams. S6 streams by far dominate the stream length on the randomly selected blocks. One opening had a high of 92 m/ha TAUP of class S6 streams within the harvested area. According to this study the strategy of excluding class S6 streams from the total area of the cutblock was less common. Only 13.6 m/ha TAUP of class S6 streams occurred inside cutblocks while class S6 streams occurred inside the total area of cutblocks at a rate of 37.4 m/ha TAUP. Of the length of class S6 occurring inside the total area 63% was clearcut harvested.

In conclusion, with regard to silviculture systems the strategy of excluding class S1, S2, S3, S4 and even S5 streams from the total area of cutblocks is a good strategy, regardless of the kind of silviculture systems. Since retention silviculture systems retain more mature timber, there is more opportunity to protect class S4 streams inside cutblocks without clearcut harvesting them.

Figures 30 to 32 show some examples from the 30 randomly selected cutblocks of where streams occur relative to cutblock.

Figure 30 Cutblock ACE 750A Streams

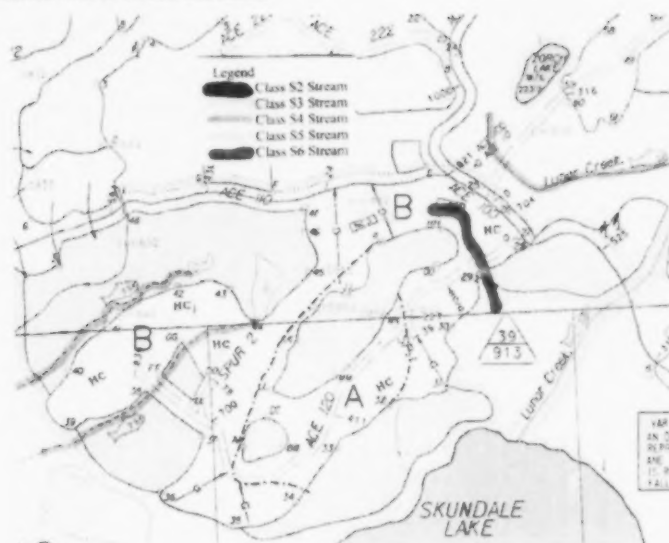


Figure 28 shows cutblock ACE 750A which is a retention silviculture system opening which occurs on rolling terrain adjacent to a lake with fisheries values. Class S3 Lunar Creek and two class S4 streams are largely excluded from the opening. Only a short reach of a class S6 stream is included within the harvested portion of the opening.

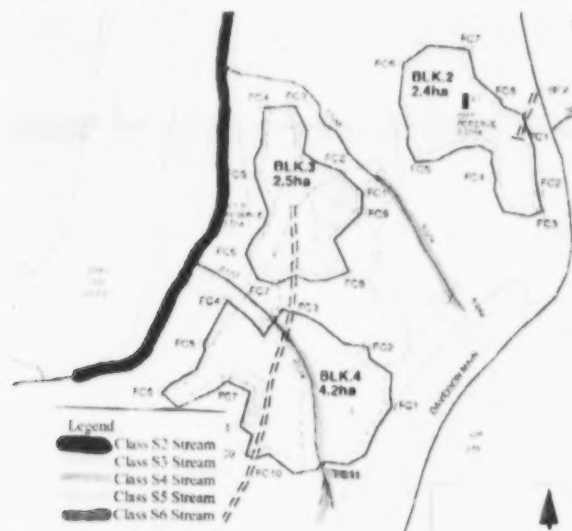
Figure 31 Cutblock H216A Streams





Cutblock H216A is a clearcut with reserve silviculture system opening close to Cumshewa Inlet. A class S2, S3 and S4 stream system is excluded from the harvested portion of the cutblock. Even most of the class S6 is excluded from the opening except for a short reach. The photo shows the class S2 reach.

Figure 32 Cutblock TOR 039 Streams



Cutblock TOR 039 is a clearcut with reserve silviculture system. The class S2 and S3 streams are excluded from the opening. Some class S4 reaches are excluded and some are clearcut harvested.

A significant issue encountered during the field work involved windthrow and fisheries streams. Six of the thirty harvest openings had windthrow that impacted streams in a significant manner. These windthrow events were not necessarily large, measuring the area of the windthrow and

expressing it as a percentage of the area harvested or even the length of stream associated with the openings would not be a significant number. However, they affect a very important and sensitive resource.

Figure 33 Cutblock A62302 Streams and Windthrow



Cutblock A62302 is a clearcut with reserve silviculture system. The SP predicted a moderate windthrow hazard at the location where windthrow blew down the riparian management and reserve zone extending to a class S2 stream.

Figure 34 Cutblock A58446 Stream and Windthrow



Clearcut with reserve cutblock A58446 had boundary windthrow through a windthrow reserve zone to deposit debris into a class S3 stream (stream is in the bottom left corner of the photo).

Figure 35 Cutblock FLO 1002 Stream and Windthrow



Cutblock FLO 1002 is a retention silviculture system. Blowdown occurred through a windthrow management zone, a strip of retention area, management zone, the riparian management and reserve zone on both sides of the stream affecting a class S3 stream (see map at figure 24).

Silviculture Prescriptions did not provide for mitigation treatments in the event of windthrow affecting fisheries streams. It is clear that government agencies would have to become involved if mitigation treatments are considered.

I. Riparian Zone Management

Section H above discussing fisheries values also has direct implications to the management of riparian reserve and management zones. In both clearcut with reserves and retention silviculture system cutblocks a significant proportion of the riparian areas, particularly those of streams with fisheries values, are managed by excluding them from the harvested portion of the opening. Riparian areas are included in WTPs, retention areas, CMT reserves or harvest strata with high levels of retention.

Figure 18 shows class S4 streams with 10 metres of the riparian management zone of clearcut with reserve cutblock GRAY 06 that is designated as a harvest stratum with very low volume removal. This was the only block of the thirty in the study with riparian management zone retained outside of WTPs and retention areas. Figure 36 shows a photo taken from the centre of a class S4 stream through the 10m wide retention zone.

Figure 36 Cutblock GRAY 06 Class S4 Stream Riparian Management Zone With Retention



The SPs provide prescriptions for the riparian management zone for all phases of harvesting.

A standard prescription to protect streams during the yarding phase is fall away and yard away from the streams in order to prevent the introduction of debris and to protect the stream banks from scarring which may lead to sedimentation. Where fall away and yard away were not possible some special protection measures were introduced such as:

- Yard across with maximum suspension;
- Fall away if possible, if not fall directly across. Avoid bucking and limbing within the channel. If damage occurs to streambank seed damaged area; and
- To facilitate hoe-chuck yarding a section of the stream will be clearcut logged and logs yarded over the stream. Where possible logs will be fully suspended over the stream or stringers or sill logs are placed to protect stream banks.

The SPs also prescribed special actions during road construction such as:

- Maintain drainage during road construction;
- Remove debris accumulations introduced during construction; and
- Assess culverts to insure proper drainage after harvest.

Prescriptions for stream cleaning varied widely. Figures 37 to 39 provide some examples of stream cleaning from the thirty survey cutblocks:

- No cleaning;
- Assess each stream for cleaning requirements concurrent with harvest, where required remove introduced debris;
- Cleaning;
- Remove introduced large woody debris concurrent with harvest;
- If coarse woody debris is found within the stream it will be removed; and

- An assessment of for stream cleaning will be done post-harvest. If introduced coarse woody debris is found within the stream it will be removed.

While this was not an audit the author noted several instances where a stream was prescribed for some level of stream cleaning and the treatment appeared not to have been completed.

Figure 37 Cutblock IAN 708 Class S4 Stream Cleaning



Figure 38 Cutblock SH 50C Class S6 Stream Cleaning



Block SH 50C is a retention silviculture system cutblock. Stream cleaning occurred on this cutblock by helicopter using a grapple.

Figure 39 Cutblock 94 Class S6 Stream Cleaning



Cutblock 94 is a clearcut with reserve silviculture system. The photo shows a class S6 stream with cleaning.

Another prescription, though not common is for the retention of non-merchantable trees (called 'retain non-merch') in the riparian zone. Saplings and regenerating trees of all species are retained in the riparian management zone of streams. Of the thirty cutblocks randomly sampled three SPs had specific prescriptions to retain non-merchantable trees in the riparian zone. In addition to these cutblocks, one licensee applies a universal prescription to retain non-merchantable trees along all class S4 streams. Figures 40 and 41 provide some examples of the retention of non-merchantable trees in the riparian zone. The author noted that in some cases while the retention of non-merchantable trees was prescribed, very few were actually retained.

Figure 40 Cutblock SH 50D Riparian Retain Non Merch





Cutblock SH 50D is a retention opening. The stream in the photo is also a gully through the cutblock. The stream was cleaned and prescribed for retention of non-merchantable materials. The second photo shows a view of the top of the gully break, still inside the riparian management zone of the class S6 stream with non-merchantable vegetation retained.

Figure 41 Cutblock TOR 038 Class S4 Stream Retain Non Merch



Block TOR 038 is a clearcut with retention cutblock. The photo shows a class S4 stream with non-merchantable trees retained in the riparian management zone.

Windthrow of 'retain non-merch' was also observed, though not on one of the 30 randomly selected openings. See figure 42 for an example, though the author noted that this situation was not common. The windthrow resulted in the deposition of small sized debris into the streams.

Figure 42 Cutblock NAD 102 Retain Non-Merch On Class S4 With Windthrow



J. Culturally Modified Trees

Windthrow also had an impact on culturally modified trees (CMTs). Of the 46 CMTs identified in or around the survey cutblocks two had been affected by windthrow and another two were possibly affected. Considering the percentage area of CMT reserve area or even the percentage of CMTs affected by windthrow the rates are low. However, this forest resource is considered to be very important. Figure 43 and 44 show CMT management areas affected by windthrow. In figure 43 the CMT is still standing while the surrounding stand has been affected. In figure 44 it was difficult to determine which tree was the CMT and the author could not determine if the CMT had been affected by windthrow.

Figure 43 Cutblock EAST 03 CMT Management Area Windthrow



Figure 44 Cutblock TOR 038 CMT Reserve With Windthrow



K. Terrain Stability

On three randomly selected blocks, which is a rate of 10%, terrain instability events were observed:

- A very small slump was observed on steep ground;
- On one cutblock there was a torrent that appeared to have originated above the harvest block (figure 45) and two slides that also originated above the harvest block (figure 46). The author does not have the expertise to determine whether or not harvesting was a causal factor in these events; and
- On one cutblock there was a large slump (figure 47).

Figure 45 Cutblock AWUN 84 Torrent



Figure 46 Cutblock AWUN 84 Slide



Figure 47 Cutblock 94 Slump



L. Gullies

On 8 of the 30 randomly selected cutblocks gullies were identified in the SP, which is a rate of 27%. Most of the gullies are associated with class S5 water courses.

Over 8 cutblocks there was a total of approximately 3,843 metres of gully occurring in 23 gullies. Only 6% of this gully length occurred inside harvested portions of the opening. The remainder occurred inside the opening in WTPs or retention areas or excluded from the cutblock. The occurrence of gully is provided graphically in figure 48. Figure 49 shows a gully in a WTP. Figure 50 shows a gully in the harvested portion of a cutblock and the same cutblock with the gully in the WTP.

Figure 48 Location Of Gullies By Gully Length

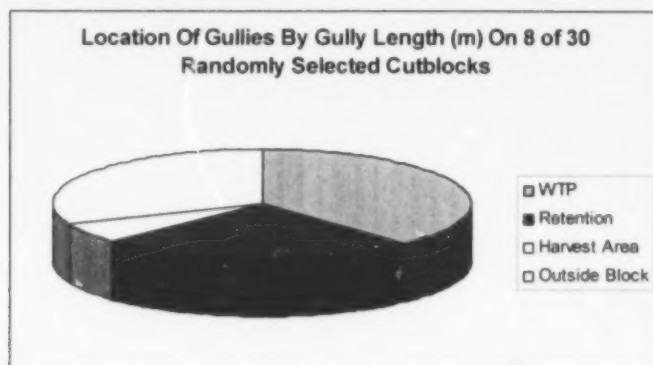


Figure 49 Cutblock 254 Gully In WTP



Figure 50 Cutblock 254 Gully In Harvest Area



Windthrow was observed along one gully. In this case the gully was also a WTP along the edge of the cutblock. While the stream associated with this gully is a class S5 stream with no fisheries values, there are significant implications to windthrow of a gully. Gullies are by definition steep-sided (over 60% slope). Windthrow exposes sediment to erosion by removing the forest floor and roots which stabilize the gully walls. The removal of the root systems further exposes the slopes to instability. If the windthrow is considered on an area basis against TAUP or even against the total length of gully or streams the rates would not be significant. However, the effects can still be significant. Figure 51 shows this gully with windthrow.

Figure 51 Cutblock 263 Gully With Windthrow



L. Resource values

A variety of resource values are managed at the stand level through the SP. Some of the specific problems and issues associated with the management of these resources are discussed in section 4 sub-sections E to K. The management of forest resources of the 30 randomly selected cutblocks generally is discussed in this sub-section.

Wildlife and Biodiversity

A specific wildlife assessment conducted by an expert was conducted on only one of the thirty harvest openings. This was a marbled murrelet survey in a drainage that also identified potential habitat at the stand level.

Wildlife features were noted on four of the thirty cutblocks or 13%. Two were bear dens. One was managed by excluding it from the opening and the other by prescribing a wildlife tree patch around the bear den. WTPs were prescribed along the outside boundary cutblocks and, less commonly, internal to the opening. A common strategy is to prescribe the WTP along streams, often overlapping the riparian reserve zones of fish streams classes S1, S2 or S3.

The amount of windthrow prescribed on the thirty randomly selected harvest areas was discussed in section E. This section also discussed the impact of windthrow on WTPs.

While the size of WTPs addresses **quantity**, there is no easy measure for the **quality** of WTPs. One common way for the forest managers to characterize the WTPs was to compare the WTP to the stand being harvested. Recall in section C the discussion regarding management objectives. Sixteen of twenty nine (one harvest block was a clearcut) cutblock SPs made specific statements that the WTP was representative of the stands harvested. The author had a concern with only one WTP field reviewed regarding the representativeness of the WTP, though not all WTPs were field reviewed.

Many of the SPs also includes statements describing the values important to the WTP. Some examples of statements include:

"The WTP will provide for tree and understory plant species diversity, structural diversity and wildlife habitat protection. The WTP also provides for recruitment of standing dead wildlife trees (snags) and for recruitment of CWD."

"The WTP will provide wildlife habitat and maintain old-growth features at the stand level. The WTP will be retained until other suitable trees can offer equivalent replacement habitat and structural diversity."

"The 6.5 ha reserve includes gullies, streams and steep inoperable terrain and has been designated to protect riparian and slope stability concerns downstream and within the gully systems as well as providing buffers for windthrow. The reserve is also representative of the logged portions of the forest and is contiguous with the WTP."

Many SPs also discuss the value to wildlife and biodiversity of other types of retention including CMT reserves, retention areas, windthrow management areas and even adjacent mature timber.

Recreation

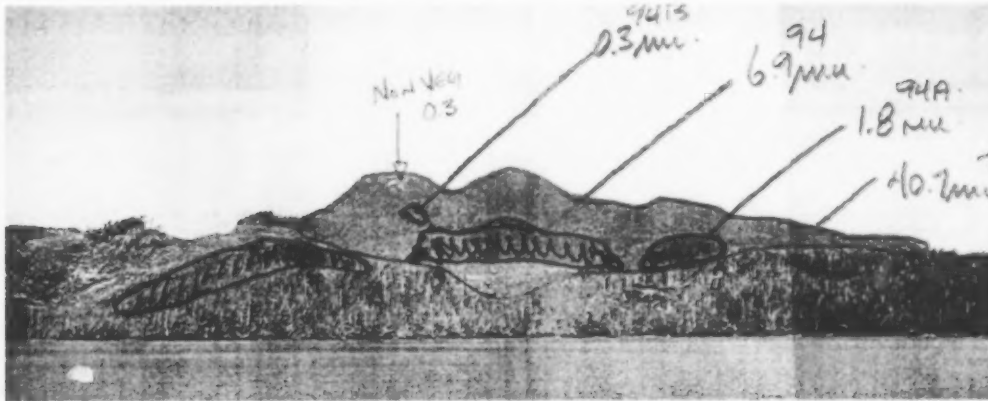
None of the 30 cutblocks of the random survey had special features identified for recreation. One cutblock, or 3% of the sample, had an assessment conducted for recreation. In that case an assessment was conducted for caves in a limestone bedrock area. The SPs identified general recreation opportunities such as hunting or four wheel drive opportunities.

Visual resource

Visual impact assessments were conducted on 14 of the 30 randomly selected cutblocks, a rate of 47%. Of the 14 blocks twelve had visual resources that required management. Visual resources are managed by cutblock design.

Silviculture system can have a significant influence on the management of the visual resource. Silviculture systems that avoid clearcutting are often employed by licensees at locations where visuals are a concern. Figure 49 shows the photo collage used by the licensee in the visual impact assessment of cutblock 94, clearcut with reserve silviculture system.

Figure 52 Cutblock 94 Visual Impact Assessment Photo Collage



CMT

Assessments for CMTs were conducted on sixteen of thirty randomly selected cutblocks. The assessments were conducted in all cases by Council of the Haida Nation crews. Of the sixteen harvest blocks assessed (53%), eight of the cutblocks, or 27%, were found to have CMTs. For one block there were no records available describing the number of CMTs. Over seven blocks then, 46 individual CMTs were identified. Figures 2, 18 (CMT located in eastern reserve), 20 and 21 show maps indicated how some CMTs were managed.

The CMTs in these eight harvest areas were treated as follows:

- 13 CMTs were placed in a no-harvest CMT reserve;
- 1 CMT was retained in a no-harvest riparian management zone of a class S4 stream;
- 2 CMTs were retained in a standards unit that allowed a very low level of harvest;
- An unspecified number of CMTs were excluded from the opening;
- 1 CMT was retained in a 0.01 hectare CMT reserve
- 20 CMTs were found, 8 were excluded from the opening, 6 placed in CMT reserves and 6 in WTPs; and
- 9 CMTs were found, 1 was placed in a WTP and 8 in four CMT reserves.

Photos of CMTs can be found in Section 5.

Terrain

Terrain stability assessments were conducted by experts on 14 of 30 randomly selected harvest openings, a rate of 47%. Terrain issues that were identified were managed in the design of the harvest blocks.

Windthrow

Windthrow has been discussed under several other sections including sections discussing silviculture systems, fisheries and CMTs.

Specific windthrow assessments were conducted by specialists on 2 of 30 randomly selected cutblocks, a rate of 6%. On all other cutblocks company personnel conducted the windthrow assessments. Licensee personnel interviewed stated that crews conducting windthrow assessments have training. Company personnel use a Windthrow Handbook to assist in assessments.

Edge treatments to mitigate against windthrow occurred on four openings. The strategies on these blocks were:

- Adjacent to a class S3 stream a windthrow management zone was prescribed and several windthrow prone trees were removed;
- Adjacent to two streams with gullies windthrow management zones were prescribed and windthrow prone trees were removed;
- At a windthrow prone boundary the edge was feathered to prevent windthrow in the adjacent timber; and
- Adjacent to class S3 streams a windthrow management zone was prescribed and a few windthrow prone trees were removed.

Feathered edge treatments remove a small percentage of trees of a windthrow management zone, usually those trees considered to be most windthrow prone. The resultant feathered edge treatment resembles the pattern windthrow naturally makes on a windthrown boundary with more trees windthrown at the boundary edge and fewer trees windthrown with greater distance from the edge. Forest management personnel interviewed gave mixed testimony regarding the efficacy of this treatment. Some indicated that the treatment worked well, while others expressed doubt.

Another treatment to mitigate against windthrow is tree topping and pruning. This treatment was not encountered in the 30 random sample blocks. However, the treatment was documented in the Best Management Practices cutblocks. See the photos and discussion under Section 5. The treatment involves a trained faller climbing trees and pruning branches and topping the tree in an effort to reduce foliage surface area. As with the edge treatment more pruning is done at the edge and less pruning and topping occurs with greater distance from the edge. These skills are currently being developed on Haida Gwaii. The efficacy of this treatment is not known since the treatment is so new.

Individuals interviewed stated that windthrow is a natural ecological process of coastal forests. Many individuals interviewed stated that windthrow at boundaries including cutblocks, WTPs, retention, riparian zones and other features should be avoided if possible and considerable effort should be made to avoid windthrow. However, if windthrow occurs, salvage harvesting should be considered and the windthrow should be considered an unfortunate but unavoidable effect of harvesting.

Individual interviewed felt that where there were significant values identified such as fisheries streams, CMTs, unstable terrain, gullies or other point values, windthrow was far less acceptable as an unavoidable consequence of harvesting. Sections E to K presents considerable evidence on effects of windthrow on these important resource values.

The effect of windthrow on the resources varies with the resources. Interviewees stated the effects of windthrow are as follows:

Loss of volume and harvest opportunity: Windthrown trees can be salvage harvested. Where salvage harvesting does not occur volume is 'lost' since timber supply models do not account for the windthrow. The windthrow may make the remaining stand uneconomical to harvest, reducing harvest opportunity and further affecting the accuracy of timber supply models.

Aesthetics: Windthrow has a high visual impact particularly for the public who may not understand the difficulties of managing windthrow. Where tourists come into contact with windthrow the implications may become even more significant.

Fisheries streams: Windthrow can deposit debris into streams at rates that significantly exceed natural rates.

Sedimentation: Windthrow occurring on steep slopes expose soil and can cause the sedimentation of streams. This has a greater environmental impact on fisheries streams and gullies.

CMTs and wildlife trees: Where a specific tree has a particular value as a wildlife tree (e.g. Bear den, eagle nest etc.) or a CMT the tree can be windthrown or other blowdown trees might affect the tree by scarring or affecting the rooting of the tree with the resource value.

One licensee, Weyerhaeuser, has a formal monitoring program in place to address management issues in a formal adaptive management program. None of the other Haida Gwaii licensees have a formal monitoring program in place.

Where there are important resources at risk such as CMTs, gullies and fisheries streams forest managers have four options in terms of a strategy:

1. No harvest – the value is so important or risk is so high that harvesting is not possible;
2. Wide buffer – where the value is so important and the risk is so high a wide buffer protects the value at risk. Even if significant windthrow occurs it is not likely to affect the value at risk.
3. Edge treatment – Edge treatments such as feathering or removing windthrow prone trees can be considered. Pruning is becoming more popular and will be discussed in Section 5.
4. Harvest – Values such as gullies or fish streams can be clearcut harvested. The removal of all trees removes the risk of windthrow. Such a treatment is possible where the value is not the tree itself that could be windthrown, but some other feature such as a fisheries stream, a gully, a CMT, a recreation feature such as a cave etc.

Forest Health – Hemlock Dwarf Mistletoe

Haida Gwaii has a number of forest health issues. However, most of these, such as the hemlock sawfly or black headed budworm are concerns on a landscape level where the silviculture system of individual cutblocks has no significant influence. The forest health concern of deer browse of regenerating trees is a stand level concern, however, silviculture system has little influence since deer browse of western red cedar is universal across all silviculture systems.

The most significant forest health concern is hemlock dwarf mistletoe. Mistletoe is a plant that parasitizes western hemlock. The parasite can affect growth rates of the infected tree. In severe infection situations the wood quality and tree form can be affected. Hemlock dwarf mistletoe spreads from infected overstory trees into the

regenerating layer. Thus, any infected trees left behind along cutblock boundaries, as retention trees, in WTPs, CMT reserves etc can affect adjacent regenerating hemlock. The Ministry of Forests has a standardized methodology for measuring the infection rate of an individual stand, called the 'Hawksworth dwarf mistletoe rating system'.

All 30 of the randomly selected cutblocks had hemlock dwarf mistletoe identified along boundaries, in WTPs, reserves, retention areas etc. All cutblocks prescribed a treatment called '3 metre down', where all trees over 3 metres in height after harvest are slashed. Areas prescribed with sapling retention are of course not treated. Some of the randomly selected cutblocks had additional treatments such as the removal of heavily infected mature trees from all edges. This treatment is less acceptable in a WTP or a riparian reserve zone. Some SPs prescribed the establishment of preferred species other than hemlock. In many of the ecosystems, western red cedar is the preferred alternative to western hemlock. Due to deer browse, the establishment of cedar is expensive.

Silviculture system has an influence since the more edge that is retained on a cutblock, the greater the probability that hemlock dwarf mistletoe can become an issue. Silviculture systems such as single tree selection, shelterwood and group selection are of particular concern. Retention systems are also a concern since a significant portion of the area to be regenerated is under the influence of adjacent mature trees.

Today forest managers see hemlock dwarf mistletoe as a natural part of the ecosystem of Haida Gwaii. However, the infection of the regenerating trees should be avoided. The Ministry of Forests has a policy in effect regarding regeneration and hemlock dwarf mistletoe. In moderately and heavily infected stands a 30 metre wide band adjacent to mature forest must be established with a species other than hemlock and hemlock can only make up 20% of the crop trees at free growing (approximately 11 to 14 years after harvesting).

PART 5 – BEST MANAGEMENT PRACTICES CUTBLOCKS

A. Introduction

As part of the terms of reference for the study the licensees were provided with an opportunity to showcase cutblocks which the forest managers considered to be innovative of good examples of a silviculture system. These cutblocks were field reviewed and the SP was reviewed. No analysis was conducted on these blocks. They are described anecdotally with the assistance of maps and photographs.

B. Weyerhaeuser Cutblock Begbie 300H – Group retention silviculture system

Figure 6 provides the map and a photo for block Begbie 300 H. The cutblock was helicopter harvested. The cutblock was designed to manage for the visual resource. A gully is included in the cutblock and was assessed by a Professional Geologist and his recommendations were incorporated into the SP. The cutblock was also designed to manage a moderate to high windthrow hazard.

The SP does not provide any information about how or when the block will be harvested in the second pass.

Figure 53 Cutblock Begbie 300H – Hemlock Dwarf Mistletoe



Figure 53 shows an infected hemlock dwarf mistletoe tree adjacent to one of the harvest patches. Some minor windthrow was noted along the boundaries of the harvest patches.

C. Weyerhaeuser Cutblock AWUN 11 – Retention Silviculture System

AWUN 11 is a retention silviculture system cutblock harvested using cable and ground based equipment. The cutblock is situated on complex steep and rolling terrain and the harvest and retention patches are very cleverly located.

Figure 54 Cutblock AWUN 11 Map



The cutblock design manages fisheries values. Fisheries values are high adjacent to the block with class S2 Awun River and class S2 Talking Bear Creek. Class S3 streams are retained in the WTP or excluded from the opening. Most of the class S4 streams are retained in retention areas or are excluded from the opening.

The cutblock design also manages for the visual resource. Some windthrow was observed on the opening.

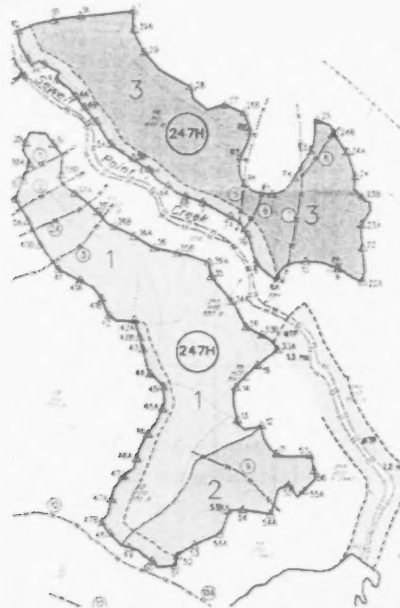
Figure 55 Cutblock AWUN 11 Harvest and Retention Areas



D. Western Cutblock 247H – Clearcut With Reserve

Cutblock 247H is a clearcut with reserve silviculture system opening on steep terrain. The block was harvested with a helicopter yarder.

Figure 56. Cutblock 247H Map



The block manages significant cultural values. The cutblock design has been modified to exclude a significant number of CMTs from the opening. Fifty metre buffers have been prescribed as well as a feathered edge to maintain a windfirm boundary adjacent to the CMT.

Special management zones have been prescribed to manage windthrow along the Sewell Point Creek gully. A minimum of 60% retention has been maintained. Though this is difficult to capture in a photo the rough 'feathered edge' is evident in figure 57.

Figure 57 Cutblock 257H Feathered Edge Boundary



The cutblock design excludes the class S3 reaches and a gully associated with Sewell Point Creek. The opening manages visual values. The WTP for the opening has been prescribed along Class S3 Sewell Point Creek. Sapling retention along many of the class S6 streams associated with the opening.

E. Western Cutblock 258 – Clearcut With Reserve

Western cutblock 258 is a clearcut with reserve silviculture system. The block occurs on steep terrain and was harvested with cable equipment.

Figure 58 Cutblock 258 Map



The cutblock was designed to manage the visual resource. Marbled murrelet habitat has been managed in the watershed through a special assessment. Two WTPs have been prescribed as highly suitable nest habitat for marbled murrelet. The large trees retained in figure 59 are evident.

Figure 59 Cutblock 258 WTP



A CMT reserve has been prescribed that also includes a gully. CMTs were identified by an assessment and have been excluded from the opening and placed in CMT reserves (see figure 60).

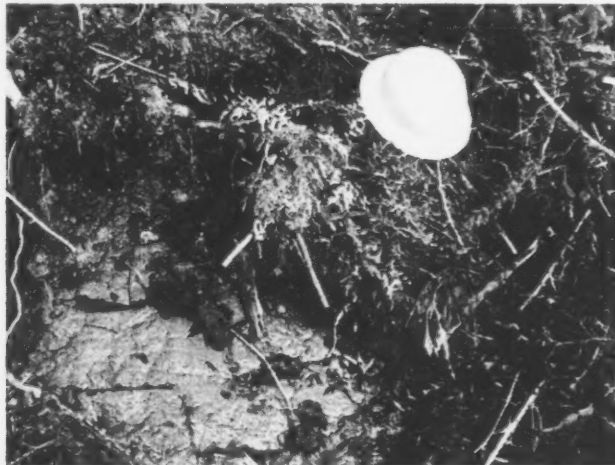
Figure 60 Cutblock 258 CMT in CMT reserve



A small area with sensitive soils was identified on the opening. The soils are thin, wet, largely organic soils on steep terrain. Clearcutting is an appropriate treatment, as recommended by a

terrain specialist. Special measures were taken to maintain full suspension yarding over the area to prevent soil disturbance. See figure 61.

Figure 61 Cutblock 258 Sensitive Soils



Windthrow was observed affecting the WTP at the northern end of the opening.

F. JS Jones COPP 03 – Retention silviculture system

JS Jones cutblock COPP 03 is a retention silviculture system cutblock on flat terrain. The opening is found in a forest dominated by western red cedar and salal. The block was harvested using hoe forwarding. The cutblock design manages class S2 Blaine Creek outside of the opening to the north. The prescription called for 25% retention of the majority of the opening and a 50% retention level of a smaller portion of the opening.

Figure 62 Cutblock COPP 03 Map

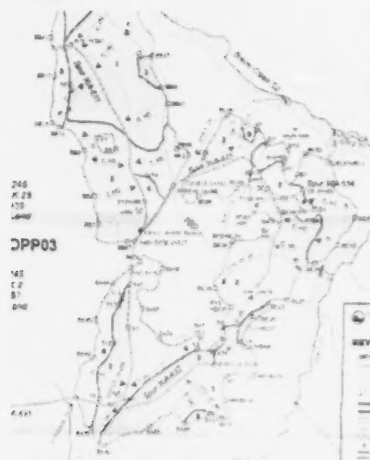


Figure 63 Cutblock COPP 03 25% Retention Harvest Area



Figure 64 Cutblock COPP 03 50% Retention Harvest Area



An eagle nest occurs outside of the opening. A number of restrictions to harvesting were prescribed including:

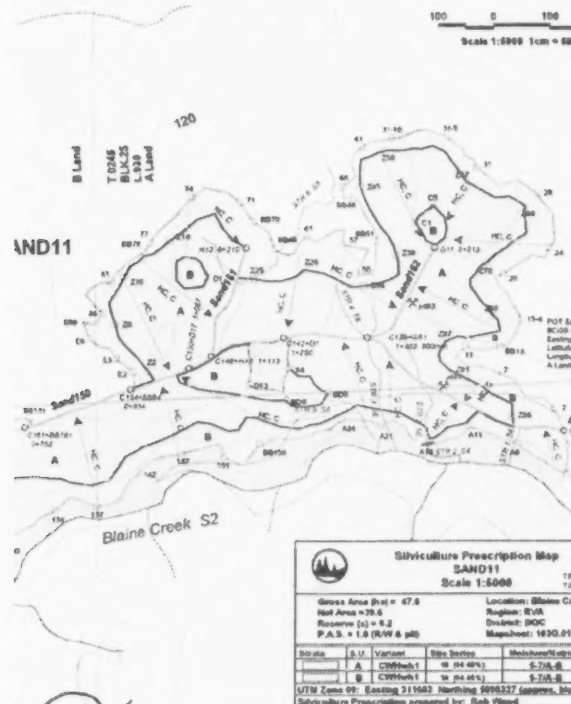
- Road building will not be undertaken within 500m of the nest site during the nesting season
- Aerial harvesting will not be undertaken within 1000m of the nest site during the nesting season
- Blasting will not be undertaken within 1000m of the nest site during the nesting season
- Falling activities, during the nesting season, will commence at least 500m from the nest site before moving towards this site in order to acclimatize the eagles slowly to the disturbance

The restrictions will be lifted if there is no active nesting at this site by June 1

G. JS Jones Cutblock SAND 11 – Retention Silviculture System

JS Jones cutblock SAND 11 is a retention silviculture system cutblock on flat terrain. The opening is found in a forest dominated by western red cedar and salal. The block was harvested using hoe forwarding.

Figure 65 Cutblock SAND 11 Map



The cutblock has been designed to exclude class S2 Blaine Creek as well as class S4 reaches of several streams. Two CMTs were identified by an assessment and were included in a CMT reserve. A WTP is prescribed along class S2 Blaine creek to the south of the opening.

Retention levels are 35% and 50% in two different areas. Trees are to be retained singly or in small clusters dispersed throughout the cutblock. Fallers select the representative retention trees based on windfirm qualities and safety. Small openings were created to ensure worker safety. The SP stated that one area was to retain a representative component of the original forest species and tree classes after harvesting. Licensee staff described that the species and tree size classes of leave trees and harvest trees were monitored during harvesting. The SP states that for another area a variety of size and age classes of cedar, pine hemlock and other species were to remain dispersed after harvesting. It is important to emphasize that the SP makes a commitment to leave a 'representative' stand after harvesting which implies the same distribution of species and size classes as the original stand. 'High grading' is less likely with this sort of a commitment. However, on the other area the SP only commits to retaining a 'variety' of species and age classes.

Figure 66 Cutblock SAND 11 35% Retention Harvest Area



H. SBFEP Cutblock A61092 – Group selection silviculture system

Figure 9 provides the map and several photos of cutblock A61092. The opening is managed as a group selection silviculture system. The opening occurs in a closed even aged stand originating after fire.

The cutblock design is primarily to manage for windthrow. A moderate windthrow risk has been assessed for the small patch cuts and a high windthrow risk has been assessed associated with the roads on the cutblock. Group selection openings have been limited to 0.1 to 0.5 hectares in size. A yarding trail network has been designed with minimal footprint on the opening and will be used over successive entries.

The SP indicates that the harvest prescribed is a removal cut of a group selection harvest. In the short term the stand structure will be an even aged structure with two well represented age classes; the original stand and the regenerated group selection openings. In the long term the stand will be converted from an even aged stand to an uneven aged stand consisting of a minimum of three well represented age classes. Successive passes will not occur until the previous entry areas have regenerated and achieved a minimum green-up height of 3m. The SP anticipates 4-5 entries with 15-20 years between entries each harvesting 20% of the basal area.

A mounding silviculture treatment has been prescribed to enhance regeneration on salal sites.

The cutblocks harvested in the vicinity of cutblock A61092 had very significant windthrow. Little windthrow was observed on the opening, though the block was only recently harvested.

I. SBFEP Cutblock A58350 – Irregular Strip Shelterwood and Clearcut With Reserves

Figure 7 presents the cutblock map and photos. The present stand is an even aged stand originating after fire in the mid-1800s.

Two windthrow management zones have been prescribed to manage a high to very high windthrow risk. Within the management zones trees will be topped and pruned to reduce windthrow risk. This is shown in figure 67.

Figure 67 Cutblock A58350 Windthrow Management Zone Pruning and Topping



Operational reserves have been prescribed making up approximately 10% of TAUP to provide for non-timber resources which are prescribed to be maintained for at least one rotation. Harvesting will occur as 'loggers choice' with 500-1500 stems per hectare remaining after harvesting. The reserves enhance protection from south-east winds and contribute to biodiversity.

The SP provides guidelines for the selection of trees to be harvested in the 'loggers choice' area including the retention of all Cw. Guidelines are also provided for the harvesting of trees.

The irregular shelterwood has been prescribed to manage windthrow. Approximately 40% of the opening area will remain in leave strips after the first pass. The opening is managed as an even aged stand made up of two age classes. The second entry is anticipated after the growth of the

first pass regenerating trees has reached 9 metres. The third entry will harvest the remaining leave strips and will occur after the second pass harvest areas have regenerated to a height of 9 metres. Salvage harvesting is permitted and the SP provides guidelines for salvage harvesting should it occur.

The cutblock was designed to exclude class S2 Kumdis Creek and a class S3 stream to the north of the opening which has also been prescribed as a WTP. The fish streams and WTP have been placed in a downwind position with regard to the block location.

The following prescriptions manage windthrow risk:

- Strips are narrow (20m) and are perpendicular to the predominant wind.
- Two narrow (8m) and curved yarding corridors prevent the wind from funnelling which would increase windthrow risk.
- A narrow road right of way (15) has been prescribed for the haul road.
- The size of proposed leave areas which will be harvested in the future increases while approaching the streams and will be sequentially harvested into the wind to favour maximum resistance to southeast winds.
- The block will be monitored every two years to ensure adequate windthrow prescriptions.

Some windthrow was observed on the opening including some windthrow of the boundary treated by pruning and topping to mitigate against windthrow.

The SP provides a discussion regarding how the prescription managed for the great blue heron and the sandhill crane. The block was designed to minimize impact on wildlife sensitive areas by excluding wetlands known to be used by sandhill cranes.

J. Husby Cutblock DIV 107 – Single tree selection silviculture system

The cutblock is found on the floodplain of class S1 Davidson Creek. The cutblock is managed as single tree selection silviculture system and was yarded with a helicopter. A photo of this cutblock is found at figure 8. A retention level of approximately 67% was prescribed.

Figure 68 Cutblock DIV 107 Map



The cutblock excludes the class S1 Davidson Creek. Some class S3 and S4 streams are found in and adjacent to the opening (figure 69). During field work some windthrow was observed into the class S3 stream.

Figure 69 Cutblock DIV 107 Class S3 Stream Through Opening



One of the stand management objectives was to maintain biodiversity and wildlife habitat by mimicking size and distribution of historic natural disturbance patterns. Small openings and a thinned residual stand mimic the natural disturbance pattern and facilitate regeneration by allowing more light and heat to reach the forest floor.

The cutblock was to be managed as a single tree selection silviculture system on an uneven aged basis. The next harvest entry is projected for approximately 30 years. The SP provided a stand structure table which provides the existing stand, the stand structure goal, the planned stand, excess trees (trees in excess of the planned stand), the planned first cut, the stand after the first cut and the projected stand just before and after the next harvest.

The SP provided for the maintenance of 'legacy trees' which are large trees to be maintained to enhance biodiversity and habitat. A target of 33% of trees over 125 cm diameter was to be retained.

A watershed assessment was conducted on Davidson Creek. This assessment recommended that windfirm management zones be retained to protect the mainstem riparian zone and active floodplain and that an experienced windthrow specialist should assess proposed cutblocks. Class S1 Davidson Creek is found from 50 to 400 metres from DIV 107. A windthrow management corridor was established by a windthrow specialist along the boundary of block closest to Davidson Creek. The windthrow management zone is approximately 20-40 m wide ribboned along the riparian reserve zone. Trees within the management zone are harvested while maintaining a very low incremental blowdown hazard. Based on the windthrow management corridor and the distance to Davidson Creek, the SP states that harvesting should have no impact on Davidson Creek. The terrain and windthrow specialist stated that "single tree selection will not make the stands substantially more wind prone, unless the selection is heavily weighted to dominants". Only 1 in 5 trees with a diameter greater than 125 cm are targeted for removal.

Despite the prescriptions to prevent windthrow, some was observed on the opening (see figure 70).

Figure 70 Cutblock DIV 107 Windthrow of Single Tree Selection Harvest Area



K. Discussion of BMP Silviculture Systems

The silviculture systems were prescribed to deal with significant resource values including:

- CMTs;
- Fisheries;

- Visual aesthetics;
- Wildlife;
- Biodiversity; and
- Windthrow.

The silviculture survey of those blocks chosen as 'best management practices' by the licensees revealed some of the same issues that were described in Part 4, the analysis of 30 randomly selected cutblocks. Some of these issues were:

- Windthrow of WTPs; and
- Windthrow of retained trees in single tree selection, irregular strip shelterwood and retention silviculture systems.

The author expects that other issues involving windthrow affecting retention areas, WTPs, riparian zones, gullies, CMTs and other values that were described in the analysis of 30 randomly selected cutblocks could also be found in the silviculture systems discussed in this section.

Some of the SPs for the alternative silviculture system cutblocks had very detailed prescriptions for the management of the opening over a rotation, though not all provided this information. It is strongly recommended that stand level prescriptions such as silviculture prescriptions lay out the anticipated treatments with options or alternatives for the rotation in general terms.

Several individuals interviewed were complementary about the more pleasing visual appearance of the single tree selection, irregular strip shelterwood, group retention, group selection and retention (with high percentage of retained trees) silviculture systems.

Several individuals interviewed were critical of the single tree selection and retention silviculture system implementation and stated that the harvested was a form of 'high grading'. They stated that at a minimum such silviculture systems had to have controls requiring the licensees to 'log the profile' of the stand. In other words, the licensees had to harvest all diameters of trees and leave the same size and species of stand after harvesting. Other interviewees went further and pointed out that they felt that some of the alternative silviculture systems were being implemented with an 'economic high grading'. While the companies prescribed logging the profile, they were still taking the most valuable trees in each diameter and species class. The individuals stated that there was a serious implication to timber supply if the stand retained for the next pass was not sufficiently valuable to harvest.

Several interviewees noted that the issue of hemlock dwarf mistletoe was aggravated by 'alternative' silviculture systems with high levels of dispersed retention.

PART 6 - CONCLUSIONS AND RECOMMENDATIONS

Part 6 provides a summary of conclusions and makes some recommendations.

Recommendations are made in bold font.

A variety of silviculture systems are in use on Haida Gwaii. At this time silviculture systems that manage stands on an even aged basis dominate. These are the clearcut with reserves and retention silviculture systems. Another even aged silviculture system that was observed was the strip shelterwood.

Uneven aged silviculture systems are much less common on the Queen Charlotte Islands. Examples include single tree selection and group selection silviculture systems.

Pojar et. al. (1999) published a paper: "Silviculture Options in the Central Coast", a report prepared for the Central Coast Land and Coastal Resource Management Plan. The Executive Summary of this paper is provided as an Appendix to this paper. The report by Pojar et al is an important starting point for this Silviculture Systems Survey of Haida Gwaii. In particular the report provides a number of recommendations that should be considered for the Haida Gwaii land use planning process. The recommendations the author considers to be particularly relevant are:

1. **Planners should recognize the environmental differences between the ecological subunits and use them in strategic planning;**
2. **Riparian forests get special treatment and attention;**
3. **Economic margin should be considered before implementing partial cutting;**
4. **Partial cutting is not recommended everywhere since this would not make ecological sense and such a strategy could have undesirable silvicultural and economic consequences.**
5. **Implement a variety of silvicultural systems and monitor blowdown and its consequences.**
6. **At the site level use partial cutting in the following applications:**
 - **As variable retention systems;**
 - **To address regeneration delay issues.**
 - **As commercial thinning;**
 - **To extract some wood from some riparian forests while retaining essential forest structure and ecosystem function; and**
 - **In redcedar/yellow cedar forest types several silviculture systems could be implemented most efficiently through hoe forwarding.**
7. **Establish a process to monitor the effectiveness of different silvicultural systems in meeting social, economic and ecological goals. Consider adaptive management as the model of this process.**

Between January 1, 2000 and March 1, 2003 approximately 287 openings were harvested with an average total area of 23.2 hectares (this includes roads, retention areas etc.) by five tenure holders or forest managers: Weyerhaeuser Ltd., Husby Forest Products Ltd., JS Jones Ltd., Western Forest Products Ltd. and the Small Business Forest Enterprise Program.

The study examined 30 randomly selected openings harvested between January 1, 2000 and March 1, 2003. The average total area of 30 randomly selected cutblocks was 25.7 hectares.

A number of openings were described as clearcuts in the silviculture prescriptions; however, in reality they had prescribed reserves. Planners and the public are interested to know which silviculture systems are in use on Haida Gwaii. In order to accurately track silviculture system use over time **the designation of silviculture system on planning documents must be based on the definitions of the silviculture systems.** Of the 30 randomly selected cutblocks 57% were clearcut with reserves, 40% were retention and 3% were clearcut silviculture systems.

Silviculture prescriptions contain stand-level management objectives. **The public must have an opportunity to influence stand level objectives.** While it is not feasible for the public to participate in the establishment of stand management objectives on all openings there must be a viable mechanism for the public to influence this process through mechanisms such as land use planning. **It is critical that stand level objectives must be oriented towards those resource values which make the stand unique or special. Furthermore management objectives must be sufficiently specific, measurable and achievable to guide management activities and allow managers and the public to measure progress over time and yet provide sufficient flexibility to allow managers a range of options to achieve the objectives.**

Reserves are prescribed to protect streams, fisheries, cultural, recreation or many other values. Most commonly reserves are prescribed to provide values important to the retention of biodiversity or the management of wildlife. Reserves can be prescribed as a variant to any silviculture system. The most common type of reserve prescribed on the 30 randomly selected cutblocks were Wildlife Tree Patches (WTPs), though other reserves included riparian reserves, Culturally Modified Tree (CMT) reserves and windthrow management reserves.

Wildlife tree patches were prescribed on 29 of 30 cutblocks. Clearcut with reserve and retention silviculture system cutblocks had WTPs prescribed. Only the single clearcut silviculture system cutblock had no reserve. Across all cutblocks the average WTP size as a percentage of total cutblock area was 9.4%. The WTPs were prescribed to manage wildlife and biodiversity values. In addition to these values WTPs were placed so as to also manage fisheries, gullies, unstable terrain and culturally modified trees and other values. The data suggests that clearcut with reserve cutblocks have a greater percentage of WTP prescribed than retention cutblocks, all of which also had WTPs.

Retention cutblocks have areas prescribed for retention to manage for values other than regeneration. On Haida Gwaii this is generally for wildlife and biodiversity, to keep the majority of the cutblock under the influence of mature trees. Retention as a percentage is considered against total area under the prescription. Across all 30 randomly selected cutblocks the retention level was 11.2%. When only the 8 retention silviculture system cutblocks are considered the average retention was 26%.

Silviculture prescriptions of the different licensees did not consistently calculate the percentage of WTP and retention. **The percentage of WTP and retention must be reported and must be expressed against total area under the prescription.**

Retention prescriptions did not state the length of time the retention areas were to be retained. The study assumed that retention areas prescribed by the licensees are for one rotation. **Retention prescriptions must state the length of time the retention areas are to be managed.**

Twelve of the 30 randomly selected cutblocks had 'other reserves' prescribed (in these cases reserves other than WTPs and retention). The author considered 'other reserves' to be areas with

the clear majority of mature trees retained. In the sample 'other reserves' included riparian management zones, windthrow management zones, partial harvest strata and culturally modified tree management areas. Across 30 cutblocks the 'other reserves' account for approximately 2% of the total area under the prescription.

When all mature timber retained after harvesting is considered the WTP, retention and other reserves add to 23% of the total area under the prescription. When all mature timber retained is considered by silviculture system the data strongly suggests that the retention silviculture system retains perhaps twice as much mature timber within the total area than the clearcut with reserves. **The retention silviculture system is recommended over the clearcut with reserves where there are significant resource values other than timber since this silviculture system provides more opportunity to retain mature trees.**

Windthrow was found to be the most significant issue encountered on the cutblocks of Haida Gwaii. The total area of the windthrow was estimated on the 30 randomly selected cutblocks.

The problem of windthrow of retention areas is largely an issue with the retention silviculture system cutblocks. Retention areas of the retention silviculture system experienced a windthrow rate of 15% expressed as a percentage of the total retention area. The study estimated that 23% of patches are isolated in the harvest area ('islands') or project into the harvest area but are contiguous with boundaries ('peninsulas'). The estimated windthrow rates of the islands and peninsulas are approximately 51%. However, this data was not collected rigorously and the identification of islands and peninsulas was subjective so this data must be considered as an indication or a trend only.

Most retention silviculture systems had provisions for salvage harvesting of the windthrown retention areas. **It is strongly recommended that the practice of salvage harvesting of windthrow retention areas be considered by the land use planning process.** Windthrown trees have ecological value as coarse woody debris. More importantly though are the implications of the windthrow of retention areas on timber supply and the impact on aesthetics. How much windthrow of retention areas is acceptable?

The study found that WTPs had a windthrow rate of 3% of the total WTP area prescribed. While these rates are not excessive, **the land use planning process should give some thought to the acceptability of windthrow of WTPs.** The 'other reserves' areas (riparian management zones, CMT areas, windthrow management zones etc.) had a similar windthrow rate of 2.7%.

In conclusion, with regard to windthrow and cutblock area, the windthrow of retention areas is a significant issue which is largely exclusive to the retention silviculture system. The windthrow rates of WTPs as well as other reserves are low and since WTP rates are lower on retention silviculture system cutblocks than clearcut with reserves, the windthrow of WTPs and other reserves should be less of an issue with the retention silviculture system.

Fisheries streams (class S1 to S4) occurred in or directly adjacent to 30% of the 30 randomly selected openings. The amount of each class of stream was considered by the study and was expressed in terms of length of stream in metres against total area under the prescription (m/ha TAUP).

No class S1 and S2 streams were included inside cutblocks (not even in reserves) of the 30 random sample blocks.

The rate of class S3 streams included inside the total area was 2.8 m/ha TAUP while 3.2 m/ha TAUP of class S3 streams occurred directly adjacent to the cutblocks. However, almost all (except where class S3 streams crossed roads) of the class S3 streams that were included inside the total area under the prescription occurred in WTPs or retention areas.

Class S4 streams were included inside openings at a rate of 6.2 m/ha TAUP while class S4s were excluded from openings at a rate of 6.4 m/ha TAUP. For the stream length of class S4 streams inside the cutblocks 3.9 m/ha TAUP was retained in WTPs and retention areas while 2.3 m/ha was clearcut. In conclusion when only the area inside of the total area of the cutblock is considered 37% of class S4 stream length is clearcut and 63% protected in reserves or WTPs.

This study was able to conclude that approximately half of the class S3 and class S4 streams were managed by excluding them from the openings so that they were directly adjacent to the opening. Presumably future adjacent harvesting would also exclude these class S3 and class S4 streams. Forest managers on the Queen Charlotte Islands are managing half of the class S3 and class S4 streams occurring in or directly adjacent to cutblocks by excluding them from openings.

Since the exclusion of class S4 streams is such an effective strategy for managing fisheries values the author considers it to be worthwhile including the length of stream outside but directly adjacent to class S4 streams when considering the rate at which class S4 streams are clearcut. According to the sample of 30 randomly selected openings, approximately 18% of class S4 streams in and directly adjacent to cutblocks are being clearcut harvested on Haida Gwaii

Class S5 streams are non-fish bearing streams and these occurred at a lower rate in the random sample of 30 cutblocks. A total of 2.9 m/ha TAUP of class S5 occurred inside the total area of cutblocks while 1.4 m/ha TAUP of class S5 occurred directly adjacent to the cutblocks. In conclusion when only the area inside of the total area of the cutblock is considered 21% of class S4 stream length is clearcut and 79% protected in reserves or WTPs.

Class S6 streams are small non-fish bearing streams. According to this study the strategy of excluding class S6 streams from the total area of the cutblock was less common. Only 13.6 m/ha TAUP of class S6 streams occurred inside cutblocks while class S6 streams occurred inside the total area of cutblocks at a rate of 37.4 m/ha TAUP. Of the length of class S6 occurring inside the total area 63% was clearcut harvested.

In conclusion, with regard to silviculture systems the strategy of excluding class S1, S2, S3, S4 and even S5 streams from the total area of cutblocks is a good strategy, regardless of the kind of silviculture systems. Since retention silviculture systems retain more mature timber, there is more opportunity to protect class S4 streams inside cutblocks without clearcut harvesting them.

Windthrow was again found to be a significant issue with regard to fisheries values. Six of 30 cutblocks had windthrow that affected streams that the author considered to be 'serious' environmental issues. The total area of land affected or the length of stream affected was not significant, the issue was with the windthrow and the value of the resource. Silviculture prescriptions did not provide for windthrow and fisheries streams. These windthrow events affecting fisheries values affect both clearcut with reserve and retention silviculture systems.

Riparian management zones were protected by various treatments through the falling, yarding and road building phases. Stream cleaning was inconsistently prescribed and inconsistently implemented with a variety of strategies employed (e.g. Hand clean, machine clean etc.). Another prescription encountered for riparian zones was the retention of non-merchantable

vegetation in the riparian management zone. This strategy was not used often, nor was it very successfully implemented.

Culturally modified trees (CMTs) were managed in a variety of ways through the layout of harvest areas with no special considerations to silviculture system. CMTs were excluded from openings or placed in WTPs, retention areas or other reserves such as CMT reserves.

Up to 4 of the 46 CMTs identified on SPs and maps were affected by windthrow. In each case the CMTs were retained in small timber islands. As with the fisheries streams the area affected was not significant however, this resource is considered to be particularly valuable.

Gullies occurred in or adjacent to 8 of the 30 cutblocks. Most of the gully length was retained in WTPs or retention areas with only a very small percentage included within harvested portions of the cutblock with no special considerations to silviculture system. Windthrow was also observed affecting gullies. As with fisheries and CMT values, the area affected was not significant but the impact on the resource was significant due to the sensitivity of the resource.

Where there are important resources at risk such as CMTs, gullies and fisheries streams forest managers have four options in terms of a strategy:

1. No harvest – the value is so important or risk is so high that harvesting is not possible;
2. Wide buffer – where the value is so important and the risk is so high a wide buffer protects the value at risk. Even if significant windthrow occurs it is not likely to affect the value at risk.
3. Edge treatment – Edge treatments such as feathering or removing windthrow prone trees can be considered. Pruning is becoming more popular and will be discussed in Section 5.
4. Harvest – Values such as gullies or fish streams can be clearcut harvested. The removal of all trees removes the risk of windthrow. Such a treatment is possible where the value is not the tree itself that could be windthrown, but some other feature such as a fisheries stream, a gully, a CMT, a recreation feature such as a cave etc.

The author observed examples of silviculture systems that the licensees considered to be 'best management practices'. These included the clearcut with reserve and retention systems found in the random sample but also included the following 'alternative' silviculture systems:

- Group retention;
- Retention (with retention percentages as high as 50%)
- Group selection;
- Irregular strip shelterwood; and
- Single tree selection.

The alternative silviculture systems were prescribed to deal with significant resource values including:

- CMTs;
- Fisheries;
- Visual aesthetics;
- Wildlife;
- Biodiversity; and
- Windthrow.

The author concludes that the alternative silviculture systems provided managers with greater flexibility to manage resource values other than timber. **Where resource values other than**

timber are identified and are significant, alternative silviculture systems such as group retention, retention (with retention percentages as high as 50%), group selection, irregular strip shelterwood and single tree selection should be considered.

Silviculture prescriptions for all silviculture systems, but particularly for the alternative silviculture systems, must describe in general terms all anticipated activities for the rotation of the cutblock.

Windthrow was observed on the best management practices blocks despite prescriptions to reduce windthrow hazard. **The author recommends that on all silviculture systems employed on the Queen Charlotte Islands, windthrow must be considered where there are fisheries, gullies, CMTs, wildlife trees or other values at risk and considerable effort must be taken to protect the resources.** Windthrow along retention and WTP boundaries, is less significant and may not require as rigorous a prescription to protect them. **A universal windthrow monitoring system is required for the Queen Charlotte Islands. In particular windthrow effects on high resource values such as gullies, fisheries streams and CMTs must be monitored and the trends in windthrow by silviculture system and other criteria must be monitored for all licensees in order to provide for adaptive management.**

Several individuals interviewed were critical of the single tree selection and retention silviculture system implementation and stated that the harvested was a form of 'high grading'. They stated that at a minimum such silviculture systems had to have controls requiring the licensees to 'log the profile' of the stand. In other words, the licensees had to harvest all diameters of trees and leave the same size and species of stand after harvesting. Other interviewees went further and pointed out that they felt that some of the alternative silviculture systems were being implemented with an 'economic high grading'. While the companies prescribed logging the profile, they were still taking the most valuable trees in each diameter and species class. The individuals stated that there was a serious implication to timber supply if the stand retained for the next pass was not sufficiently valuable to harvest. **The author recommends that 'alternative' silviculture systems with high percentages of dispersed or clumped retention, must have prescriptions that ensure the retention of a stand with a similar species composition, diameter classes and value after harvesting.**

APPENDIX A - POJAR PAPER EXECUTIVE SUMMARY

SILVICULTURAL OPTIONS IN THE CENTRAL COAST

**A REPORT PREPARED FOR THE
CENTRAL COAST LAND AND COASTAL RESOURCE
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EXECUTIVE SUMMARY

This report assesses the ecological suitability, sustainability, practicality, utility, and applicability of various silvicultural systems to the Central Coast. We provide recommendations on whether or how to apply the alternative models and practices at the strategic level.

The Central Coast is most like the North Coast and the southern portion of the Kalum Forest District. It has less similarity to Vancouver Island and the southwest mainland coast. We define three ecological subunits within the plan area:

HECATE LOWLAND (hypermaritime)

- a distinctive and consistent landscape, stretching from Johnstone Strait to Prince Rupert
- really nothing else like it in B.C., but some similarities to northern Vancouver Island (n of Port Hardy) and the western fringe of Vancouver Island, as well as parts of Q.C.I.

OUTER COAST MOUNTAINS (maritime)

- probably what most people would consider "typical" B.C. coast; mountainous, wet, thickly forested fiordland
- similar forests occur from Vancouver Island and the North Shore Mountains north to the Nass River
- similar environment to much of the wetter portion of Vancouver Island, especially the windward mountains, including Clayoquot Sound

INNER COAST MOUNTAINS (submaritime or transitional)

- mostly formidable hinterland, probably the most extreme terrain in B.C.
- similar forests occur on southwest mainland (e.g., Squamish-Pemberton area) and some leeward parts of Vancouver Island (because of rainshadow effect, some moisture stress, fire history, and Douglas-fir---at least at lower elevations)
- forests at higher elevations more like those to the north, in Kalum Forest District

The Operating Environment is most similar to that of the North Coast (but there is virtually no experience of partial cutting in that district), not much like that of Vancouver Island.

Communities are unusually small and isolated, even compared to the North Coast. The majority of permanent residents are First Nations. Other than logging and fishing, there is little resource development. The operable landbase is a small proportion (12%) of the total. There is a short operating season, and virtually no local processing facilities. Most undeveloped watersheds do not have continuous expanses of productive accessible timber, from valleybottom to ridgetop, as used to be fairly common on Vancouver Island and even in some Q.C.I. drainages. Timber is interrupted (by cliffs, slides, avalanche tracks, wetlands, and other inoperable areas) and patchy, so there are more roads/m³---except when helicopters are used. Harvesting areas and camps are remote, and often disconnected. Most forests are very old, the rest are juvenile or young; there are few middle-aged and mature (40-210 years old); there is little opportunity for commercial thinning at present. The distribution of timber types (mostly hemlock-amabilis fir and redcedar-leading) is most like that of North Coast, but also quite similar to that of northern Vancouver Island and Clayoquot Sound. Timber quality and recoverable volume/ha are lower than on Vancouver Island. Wood for the next 10-20 years is projected to come primarily from Outer

Coast Mountains and Hecate Lowland, and increasingly from low productivity redcedar-hemlock stands and helicopter-accessible stands (the latter a coast-wide trend but more pronounced in Central Coast). This means that licensees will probably be harvesting stands less valuable and more costly than at present.

Natural disturbances in the Central Coast differ between the Hecate Lowland and Outer Coast Mountains (largely Natural Disturbance Type 1) and the Inner Coast Mountains (largely Natural Disturbance Type 2). In the Hecate Lowland and Outer Coast Mountains, fire is rarely an important natural disturbance agent. Forest stands tend to be very old and structurally complex, uneven-aged with significant amounts of dead wood standing (snags) and on the ground (coarse woody debris). Disturbances in these older stands are small-scale in nature, primarily involving the creation of canopy 'gaps' by the death of individual (or small groups of) canopy trees. Younger stands occupy a small percentage of most landscapes, and are produced by blowdown, mass movements, and floods. Insects and disease are generally not important disturbance agents in old-growth stands, though they do kill individual trees or small clumps of trees, and they become more important in second-growth stands. In the Inner Coast Mountains, fires have been important as disturbance agents, and large portions of the landscape---at least at lower and middle elevations---probably have regenerated as even-aged stands on a regular (200-300) year basis. Because the stands are younger and burn more regularly than in NDT1, stand structure will be less complex, with smaller volumes of dead wood in the stands. Still, with time between disturbances, these stands will develop some structural complexity as gap processes are initiated. Windthrow and landslides are generally much less important here, whereas snow avalanches become increasingly important from the Outer to the Inner Coast Mountains.

The bulk of logging in next 10-20 years will be in forests with NDT1 (ecosystems with rare stand-initiating events; gap dynamics prevail; opening sizes typically 1 to a few tree heights in width, or 0.1 to 3-4 ha in size; larger openings occasional). Forest management that approximated such a disturbance regime would call for lots of small openings, a few larger cutblocks, and for more "biological legacies" to be left behind in the openings

Forests in the Central Coast develop much as they do elsewhere in coastal B.C. Successional pathways depend on the nature and intensity of the associated disturbance and on the regeneration cohort; the scenarios play out in reasonably well-understood ways, which foresters can either embrace or try to manipulate.

Except for very large clearcuts (approaching 500 ha) and coppicing, there are no compelling, *a priori*, biological or ecological constraints to any silvicultural system **on an individual stand basis**. But the landscape consequences depend on the rate and extent of harvest, and all sorts of factors enter the picture at the landscape scale; e.g., number of roads required, levels of canopy retention, fragmentation, age class structure. In other words, in some important ways it doesn't matter as much **how** you log as **how much** you log. Even so, one can generalize that silvicultural systems that retain a certain level or amount of critical stand structure make more ecological sense than those that don't.

Virtually all silvicultural systems, traditional and non-traditional, could be implemented in the Central Coast. There are no compelling operational (equipment, skilled labour) constraints. The

most serious silvicultural constraints centre on windthrow, high-grading, and forest pests and diseases.

We conclude that successful operations in the Central Coast must have harvesting equipment and supporting operations that are relatively mobile and provide broad flexibility. Individual operations are relatively small and short in duration; operators can not afford to retain or import equipment purpose-built for individual situations. They require equipment flexible enough in application to cover virtually all situations.

Comparative analysis of operations in the Central Coast and in similar or comparable ecosystems on Vancouver Island revealed the following distinctive operating conditions in the Central Coast:

- cutblock size is smaller
- merchantable timber volume per unit area is significantly lower
- more helicopter logging
- average haul distance and woods run distance is significantly longer
- isolated operations, requiring camp facilities in virtually all cases
- timber development per unit of road construction is significantly lower
- much more hardrock road construction
- much higher percentage of barge transport required
- additional towing transport required in many cases

These distinctive operating conditions result in the following economic differences:

- All logging cost phases analysed showed higher costs in the Central Coast, especially for timber development (roads and bridges) and administration (overhead and camp costs).
- Timber value production in the Central Coast is marginally higher. Even though average value by species is lower in all cases, operations in the Central Coast produce, on average, a significantly higher percentage of higher value redcedar.
- Average net revenue in the Central Coast is significantly lower.

While our review did observe a number of partial cutting applications, based on an analysis of cutting permit records, there is very little partial cutting being implemented in the Central Coast planning area (almost none in oldgrowth timber types). Use of partial cutting operations in similar ecosystems and forest types outside the planning area appears to be only slightly higher although the trend appears to be increasing, to meet social and market as well as silviculture and biological objectives. The biggest differences appear to be in variety of applications and in documentation of results.

Our review included a variety of partial cutting applications as well as the associated documentation. We reviewed steep-slope cable logging on both steep and moderate slopes, with dispersed retention, patch cuts, and strip cuts; helicopter logging for both dispersed and patch retention, on virtually all terrain and slope types; hoe forwarding on moderate to flat ground, for both patch and low-level dispersed retention as well as in combination with cable harvesting systems. Because of operational difficulties, safety concerns, high cost, and innovations in helicopter harvesting, industry staff will be less likely to use cable harvesting systems (particularly those requiring lateral yarding capability) in long-reach, steep-slope applications in

the future. There is a preference to use the latest grapple helicopter technology in these situations to provide the needed flexibility.

From an operational perspective, it appears that retention silviculture systems are sufficiently flexible to successfully implement in oldgrowth forests. Compared to the classical alternative silviculture systems, retention systems require less planning and layout work, and put more control of tree harvest/retention in the hands of the faller. This provides the flexibility required to respond to the variety of operational conditions associated with harvesting oldgrowth forests, including, and most importantly, worker safety.

Establishment of land use planning areas (zones?) with development of flexible management objectives could have a positive effect on timber availability and logging costs. In some (not all) drainages, the potential operational and economic advantages could help justify the expected incremental cost of doing partial cutting. Alternatively, land use planning areas with more "constraining" management objectives could promote or require use of partial cutting.

Based on a review of documented incremental costs of partial cutting, our field visits, and staff interviews, we conclude that:

- Harvesting costs will increase with an increase in the level of uniform tree retention; cable harvesting systems are the most cost-sensitive. Patch retention is not expected to be as cost-sensitive.
- Based on current and expected future economic conditions, partial cutting doesn't make economic sense everywhere but could be justified in some drainages and on some sites.
- Depending on management objectives and remaining mindful of the dangers of highgrading, partial cutting could target more valuable log species and grades, thus offsetting the higher incremental harvesting costs; in other words, it could improve the economic margin to the point of making the operation profitable.
- Site-specific rather than average conditions determine logging activity. On the right sites, or in specific drainages given the operational flexibility to harvest the right species and grade profile at the right time, there are economically viable opportunities.

We make the following recommendations:

1. That planners recognize the three ecological subunits, Hecate Lowland, Outer Coast Mountains, Inner Coast Mountains; acknowledge their environmental differences; and use them in strategic planning.
2. That riparian forests get special attention and treatment.
3. That economic margin be considered before implementing partial cutting.
4. At the current rate of cut, we don't recommend doing partial cutting everywhere, over the entire plan area, because we don't think that would be ecologically sensible, silviculturally desirable, or economically viable. We also don't recommend clearcutting everywhere, because it doesn't make ecological sense, and because it could have some undesirable silvicultural and

economic consequences.

5. Leave more biological legacies, to maintain key elements of forest structure (live trees of varying species, size and condition--including some large stems, multiple canopy layers, canopy gaps, understory patches, snags of varying size and decay class, downed logs. We also recommend that as much attention be paid to what to **leave** as to what to take.

6. Evaluate the ecological consequences of compressing and truncating natural succession in managed forests (and especially on lands designated for an emphasis on timber production), at the landscape scale. Address the problem through: landscape unit planning; successional stage distribution; deployment of a variety of silvicultural systems according to desired similarity to early and late successional stages, including non-traditional retention systems to help retain desired levels of stand structure and biological legacies; longer rotations for some stands.

7. Implement a variety of silvicultural systems, operationally not merely for demonstration purposes. Monitor any associated blowdown and its consequences, not just in or near the treated stands but also in nearby untreated, natural stands.

8. At the site level, use partial cutting in the following applications:

- In general and where circumstances warrant, as variable retention systems.
- To address regeneration delay where it is a problem, either by retaining advance regeneration of preferred species in a variable retention scenario, or by using small patch or strip cuts to protect artificial regeneration.
- As commercial thinning, where and when stand conditions are appropriate.
- To extract some wood from some (not all) riparian forests while maintaining essential forest structure and ecosystem function.
- In Douglas-fir-leading forest types in the Inner Coast Mountains, in particular by using helicopter logging on steep rocky slopes.
- In redcedar/yellow-cedar-leading types in the Hecate Lowland, where several systems (group selection, strip, group and irregular shelterwood, variable retention) could be implemented, most efficiently through hoe forwarding.

9. Establish a process to monitor the effectiveness of different silvicultural systems in meeting social, economic, and ecological goals. Consider adaptive management as a model for this process

10. In groups of individual, often parallel, small drainages (most apparent in Outer Coast Mountains), consider compressed harvesting schedules in some drainages and reduced or no activity in neighbouring ones (in other words, a staggered development schedule).

11. As another approach, consider trial use of multi-pass silvicultural prescriptions, to target species and log grades that would allow operations to work within market cycles 'normally' experienced in the lumber and pulp industry.

12. Develop ecosystem restoration projects for some valleys of the Inner Coast Mountains---

something considerably beyond the rather limited scope of "watershed restoration".

13. Continue to allow partial-cut handlogging along parts of the shoreline, with due regard to aesthetics, recreational opportunities, marine resources, and highgrading.

